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eLabFTW: As a tool for managing and documenting scientific data. A case study of its adoption at CIIMAR.

Hassan Mustafa Shoaib

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Hassan Mustafa Shoaib

Master in Information Science

Supervisor: João Daniel Aguiar de Castro

Co-Supervisor: Maria Paola Tomasino

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Approved in public examinations by the jury:

President: Prof. Doctor Teresa Silveira
Examiner: Irene Rodrigues
Supervisor: Prof. Doctor João Daniel Aguiar Castro

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Resumo

A investigação científica moderna gera grandes volumes de dados diversos, recolhidos em laboratório e no campo. Para garantir a sua preservação, reutilização e validação, é essencial uma boa gestão e documentação, feita pelos próprios investigadores. No entanto, o uso contínuo de cadernos em papel dificulta a digitalização, organização e integração com sistemas modernos.

No CIIMAR (Centro Interdisciplinar de Investigação Marinha e Ambiental), esta necessidade é ainda mais evidente devido à variedade de projetos em áreas como ecologia marinha, biotecnologia azul e alterações climáticas. A diversidade dos dados exige soluções de gestão de dados flexíveis e integradas.

Esta tese avalia a aplicação do eLabFTW, um caderno eletrónico de laboratório (ELN) plataforma, nos fluxos de trabalho dos investigadores do CIIMAR. A ferramenta permite adicionar metadados, garantir rastreabilidade, integrar com repositórios institucionais e promover uma cultura científica mais estruturada e colaborativa.

O objetivo principal é analisar a experiência dos investigadores durante a fase piloto de implementação, com vista à formulação de recomendações baseadas em evidência que incentivem práticas digitais de documentação mais seguras, organizadas e voltadas para a reutilização da informação científica.

Abstract

Modern scientific research generates large volumes of diverse data, collected in the laboratory and in the field. To ensure their preservation, reuse, and validation, good management and documentation, carried out by the researchers themselves, is essential. However, the continued use of paper notebooks hinders digitization, organization, and integration with modern systems.

At CIIMAR (Interdisciplinary Centre for Marine and Environmental Research), this need is even more evident due to the variety of projects in areas such as marine ecology, blue biotechnology, and climate change. The diversity of data demands flexible and integrated data management solutions.

This thesis evaluates the application of eLabFTW, an electronic laboratory notebook (ELN) platform, in the workflows of CIIMAR researchers. The tool allows for the addition of metadata, ensures traceability, integration with institutional repositories, and promotes a more structured and collaborative scientific culture.

The main objective is to analyse the experience of researchers during the pilot implementation phase, with a view to formulating evidence-based recommendations that encourage safer, more organized, and reusable digital documentation practices for scientific information.

UN Sustainable Development Goals

This dissertation contributes to the achievement of the United Nations Sustainable Development Goals (SDGs) by advancing scientific research, promoting knowledge sharing, and enhancing technological capabilities through the innovation and digital transformation of marine and environmental data. The work is aligned with Open Science and FAIR (Findable, Accessible, Interoperable, and Reusable) data principles, supporting the accessibility, interoperability, and long-term usability of scientific information. Its contributions are primarily associated with SDG 9 (Industry Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 14 (Life below Water), as summarized in the following table:

SDG	Target	Contribution of Dissertation	Performance Indicators & Metrics
9	**9.5**	Documenting the upgrade of technological capabilities from manual laboratory notebook practices to the implementation of an electronic laboratory notebook (eLabFTW) at CIIMAR.	Number and Percentage of researchers and laboratories using eLabFTW
	9.C	Assess users' experience with and adoption of eLabFTW and its features, and evaluate how unified digital platform can improve current research practices at CIIMAR at the institutional level and encouraging researchers to integrate eLabFTW into their daily workflows to promote the centralization of research records, and support Open Science and FAIR (Findable, Accessible, Interoperable, and Reusable) principles.	User adoption rate, usage frequency, user satisfaction and FAIR-compliant metadata records.
11	**11.6**	Use of eLabFTW can be a sustainable digital solution, alternative to paper-based laboratory notebooks, reducing paper consumption, data fragmentation and potential lab contamination risk.	Reduction in paper use, reduction in duplicated records, and user perception of improved laboratory practices.
	11.b	Results indicate that eLabFTW allows users long-term preservation, accessibility and reduced duplication of records as well as better tracking and organization of laboratory resources, protocols and experiments.	Ease of record retrieval, reduction in duplicated information, and number of protocols and experiments managed in eLabFTW.
14	**14.a**	Achieved reproducibility of environmental and marine experiments through the use of eLabFTW, including customized metadata management and multidisciplinary data integration.	Percentage of experiments with complete metadata and protocols, and number of integrated datasets or research groups.

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Hassan Mustafa Shoaib

Declaration of Honor

I declare that this dissertation is my own work and has not been previously submitted or evaluated at this or any other institution. References to other authors (statements, ideas, thoughts), as well as the use of published works fully complies with the rules of attribution and are appropriately cited in the text and bibliography, in accordance with reference standards. I am aware that plagiarism and self-plagiarism constitute academic misconduct.

I further declare that I used Artificial Intelligence (AI) tools to complete part(s) of this dissertation, and that this use and its results are duly noted and have been carefully verified to detect errors, inaccuracies, unfounded attributions, or other forms of bias in content and arguments, as well as to determine authorship.

Hassan Mustafa Shoaib

"When a person dies, his deeds end except for three: ongoing charity, knowledge that benefits others, or a righteous child who prays for his/her parents."

Prophet Muhammad Peace Be Upon Him

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Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
CIIMAR	Interdisciplinary Centre of Marine and Environmental Research
DM	Data Management
DMP	Data Management Plan
DOI	Digital Object Identifier
eCAT	Electronic Catalog
ELN	Electronic Laboratory Notebook
FAIR	Findable, Accessible, Interoperable and Reusable
FDA	Food and Drug Administration
GDPR	General Data Protection Regulation
GDP	Good Documentation Practice
GIMM	Gulbenkian Institute for Molecular Medicine
GMP	Good Manufacturing Practice
GUI	Graphical User Interface
INESC TEC	Institute for Systems and Computer Engineering, Technology and Science
IRM	Information Relationship Model
IT	Information Technology
LIM	Laboratory Inventory Management
LIMS	Laboratory Information Management System
PID	Persistent Identifier
PI	Principal Investigator
PLN	Paper Laboratory Notebook
RDM	Research Data Management
R&D	Research and Development
SDMS	Scientific Data Management System
UNESCO	United Nations Educational, Scientific and Cultural Organization.
UMG	University Medical Center Göttingen
UI	User Interface
WP	Work Package

Chapter 1

Introduction

The rapid growth of scientific data has made effective research data management (RDM) increasingly important. Research data underpin scientific discoveries and the validation of results, however, without proper organization, documentation, and preservation, data may become difficult to interpret, reproduce and reuse over time (Sharma et al., 2023; Foster et al., 2022).

Research institutions currently face several challenges, including the increasing volume of data generated and the growing need for data storage (Foster et al., 2022). These challenges are often exacerbated when research teams change or researchers leave projects, resulting in the loss of valuable contextual knowledge and reducing the long-term value of research outputs.

The increasing emphasis on Open Science and FAIR data principles, has further highlighted the importance of making the research process more transparent, accessible, interoperable, and reusable (Blanco, 2024), emphasizing the need for structured approaches to data management throughout the research lifecycle.

In response, many research institutions are adopting digital tools such as Electronic Laboratory Notebooks (ELNs) because they offer many benefits over physical lab notebooks (Vandendorpe et al., 2024), and support scientific method, data lifecycle management and data integrity (Dunie, 2017). At CIIMAR[1], efforts to improve research data management practices and experimental research documentation have led to the pilot implementation of an ELN platform, eLabFTW.

The introduction of eLabFTW aims to provide researchers with a centralized platform for managing research data while supporting institutional objectives. This initiative aligns with the growing adoption of ELNs across research institutions to enhance collaboration and establish sustainable digital research infrastructure (Badiola et al., 2015). This work focuses on evaluating the implementation of eLabFTW at CIIMAR through the experiences of a small group of researchers.

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[1] CIIMAR: https://www.ciimar.up.pt/

Specifically, it explores and examines their initial interactions with the platform, its integration into daily research practices, and its effectiveness in supporting research data management activities.

1.1 Problem and Motivation

Well structured data documentation and management practices from the early stages of the research lifecycle is essential to ensure the integrity, reproducibility, and long-term usability of research data. ELNs support this process by enabling the systematic organization, storage, and description of research data, improving interpretability over time, and facilitating data deposit in digital repositories. This enhances accessibility, preservation, and collaboration within the research community.

Despite these advantages, many research environments continue to rely on fragmented and *ad-hoc* data management practices, including paper-based records, personal devices, and local storage systems. At CIIMAR, research data management practices are still developing and are not yet fully harmonised. Experimental research data are often stored across different systems, and documentation practices vary between researchers and research groups.

This fragmentation can reduce data accessibility and interoperability, increase the risk of data loss or duplication, and make it more difficult to fully align with FAIR data principles. For this reason, developing more consistent approaches to data organization, documentation and stewardship is an important priority for supporting the long-term usability and reuse of research data.

To address these challenges, a pilot implementation of eLabFTW was launched at CIIMAR in early 2025 and is currently ongoing. The pilot aims to evaluate the platform's usability. Its integration into existing workflows, and its effectiveness in improving research data management practices. As an open-source ELN, eLabFTW offers a centralized platform for managing research data across multiple disciplines (Tovo Rabemanantsoa et al., 2021).

Although the evaluation involved a small group of researchers, the study combines semi-structured interviews, usability tasks and a complementary follow-up questionnaire to assess eLabFTW's usability and usefulness in supporting research workflows. In doing so, it seeks to provide evidence-based recommendations to support the future implementation and optimization of the platform at CIIMAR and, potentially, in similar research institutions.

1.2 Objectives

This dissertation aims to contribute to CIIMAR's broader efforts to enhance Data Management (DM) practices through the implementation of an ELN. Specifically, the study evaluates the pilot implementation of eLabFTW by assessing its usability, integration into existing research workflows, and alignment with institutional RDM policies and practices.

The findings aim to support informed decision-making regarding the broader adoption and implementation of the platform at CIIMAR. The study is guided by the following research objectives:

- **User Adoption and Usability:** Assess researchers' willingness to adopt eLabFTW and evaluate its usability and perceived usefulness in supporting daily research activities.
- **Pilot Evaluation and Utility:** Examine user experience during the pilot phase, identify the benefits and challenges associated with eLabFTW, evaluate its overall utility, and provide evidence-based recommendations for future implementation.

Data collected within the scope of this dissertation were obtained through semi-structured interviews, and usability tasks, complemented with follow-up. The analysis evaluated eLabFTW's performance in real research settings, identifies barriers to adoption, and proposes recommendations to support its effective implementation and long-term use.

1.3 Methodology

This study follows a participatory approach developed in collaboration with researchers at CIIMAR. It supports the evaluation of the eLabFTW Electronic Laboratory Notebook in real research environments, while actively engaging participants in the assessment process and contributing to the understanding of RDM practices.

The methodology is structured around an online survey as preliminary work, followed by semi-structured interviews and usability tasks. The study is conducted with a group of CIIMAR researchers, enabling engagement with researchers' workflows, data practices, and disciplinary contexts across different research groups.

The preliminary online survey explores international research institutes using eLabFTW, focusing on user experiences and challenges encountered during the implementation and training phases. Semi-structured interviews examine participants' practices related to data organization, documentation, sharing, and reuse, as well as their familiarity with ELNs to analyze international users' experiences and challenges during eLabFTW training and testing phase.

Whereas semi-structured interviews explored participants' practices related to data organization, documentation, sharing and reuse, as well as their familiarity with ELNs, metadata standards, and FAIR principles. Usability sessions assess eLabFTW's usability, perceived usefulness, and integration into daily workflows through standardized tasks simulating typical laboratory scenarios.

A complementary questionnaire was also included as part of the usability assessment to capture participants' perceptions and feedback regarding the system experience. All data are transcribed, coded, and thematically analyzed. This approach provides evidence-based insights into user experience, identifies usability and adoption challenges, and informs recommendations for improving and supporting the potential of adopting eLabFTW at CIIMAR.

1.4 Document Structure

This dissertation is organized into six main chapters, followed by appendices and references.

Chapter 1: presents the research problem and motivation for the study, defines the research objectives, outlines the adoption methodology, and provides an overview of the dissertation structure.

Chapter 2: reviews the concept and evolution of Electronic Laboratory Notebooks (ELNs). It discusses both general-purpose and domain-specific ELNs, compares their features and functionalities, and provides the theoretical foundation for understanding the role of ELNs in research data management.

Chapter 3: describes the training and testing activities conducted to gain practical experience with eLabFTW and discusses the exploratory and practical phases of platform evaluation, learning outcomes, identifies challenges encountered during training, and includes a preliminary assessment of eLabFTW, based on an online survey.

Chapter 4: outlines the research methodology adopted in this study. It describes the process through which a group of researchers volunteered to participate, participant demographics, the semi structured interview framework, the usability tasks developed for eLabFTW, and the post-usability tasks questionnaire used to evaluate participants' perceptions of the platform.

Chapter 5: presents and analyzes the results obtained from the semi-structured interviews, usability tasks, and post-usability tasks questionnaire. The chapter examines the data management practices of the researchers participating in the study, explores their interaction with eLabFTW during the pilot implementation phase, and identifies key findings related to usability, research workflows, and user perceptions of the platform.

The results provide insights into potential opportunities and challenges associated with the adoption of ELN within the CIIMAR research environment.

Chapter 6: summarizes the main findings of the study and discusses their implications for the adoption of eLabFTW within research environments.

Finally, the appendices contain supplementary materials, including the online survey, consent forms, interview script, usability tasks, post-usability tasks questionnaire and documentation regarding the use of artificial intelligence (AI) in the preparation of this dissertation. The dissertation concludes with the References section, which lists all sources consulted throughout the study.

Chapter 2

Electronic Laboratory Notebooks

Research Data Management has emerged as an important component of modern research, addressing challenges related to data integrity, curation, organization, and stewardship throughout the entire research data lifecycle. It provides a structured approach for managing research data from project inception to completion by promoting standardized practices, well-defined procedures, and support mechanisms that facilitate efficient data handling, accessibility, and reuse (Sharma et al., 2023).

This growing importance of RDM has attracted significant attention across research communities, driven by the increasing complexity and volume of data generated in contemporary research, the need for effective approaches to ensure data quality, accessibility, and long-term usability and lastly, its close alignment with the broader principles of Open Science (Woo & Yoo, 2023; UNESCO, 2021).

According to the UNESCO Open Science Vision, Open Science emphasizes transparency, accessibility, and collaboration throughout the entire research process and extends beyond traditional research practices by promoting openness at every stage of the research lifecycle (UNESCO, 2021; Blanco, 2016).

Achieving such openness requires the digital integration of research activities and data management processes. In this context, fully digital research data management infrastructures have become increasingly important, enabling seamless coordination of research workflows through the use of open-source and freely available software tools, such as Electronic Laboratory Notebooks. (Tristram et al., 2024).

In this context, Electronic Laboratory Notebooks (ELNs) have become increasingly important within the evolving digital research ecosystems, particularly in individual and interdisciplinary research projects. By supporting the digital recording, organization, sharing and preservation of research information. ELNs can help strengthen research data management practices, improve documentation consistency and facilitate the deposit of research outputs in open repositories.

However, their implementation remains uneven across institutions. Nevertheless, technological advances and increasing digitalization are expected to drive broader adoption, as

ELN platforms such as LabTrove and eLabFTW have demonstrated their effectiveness in supporting collaborative research and promoting improved data management practices. This highlights the important role of ELNs in contemporary scientific research environments (Sharma et al., 2023; Badiola et al., 2015).

This transition toward digital research practices has shaped the evolution of ELNs, transforming them from simple electronic replacements for paper notebooks into integrated platforms supporting modern research data management because ELNs address several RDM challenges by providing researchers with centralized systems for documenting experiments, managing resources, tracking changes, maintaining protocols, monitoring inventories, generating audit trails, and supporting compliance with regulatory requirements.

These capabilities enhance laboratory workflows, strengthen data integrity and traceability, and facilitate collaboration within multidisciplinary research environments (Sharma et al., 2023). Therefore, examining the historical development of ELNs provides essential context for understanding their current functionalities and future role in scientific research.

2.1 Evolution of Electronic Laboratory Notebooks

The development of ELNs reflects the broader transformation of scientific record-keeping from traditional paper-based approaches toward digital research environments. Early ELNs emerged in the late 1990s, evolving from database-based systems into web-based platforms designed to support digital documentation and data management in research laboratories (New Information Paradigms Ltd, 2025; Virtual Notebook Environment, 1998).

In 2006, Electronic Catalog (eCAT) was introduced as a web-based ELN designed for academic research environments (Goddard, Macneil and Ritchie, 2009). Subsequent versions incorporated feedback from diverse user groups, including the Food and Drug Administration (FDA) Center for Biologics Evaluation and Research, to improve functionality and usability. The platform enabled the organization of heterogeneous research data, including images, spreadsheets, experiment records, and laboratory inventories.

Although eCAT is no longer maintained, it introduced several functionalities that later became fundamental components of modern ELNs, including collaboration tools, document management, audit trails, electronic signatures, access control mechanisms, and inventory management (Goddard, Macneil and Ritchie, 2009).

These early developments highlighted the importance of scalability, usability, and cost-effectiveness as essential factors influencing successful ELN adoption and contributed to the identification of key requirements for modern ELN systems. Modern ELNs must support efficient experimental creation, documentation, analysis, and tracking while providing standardized templates, protocols, and structured approaches for research information management.

Furthermore, effective ELN systems require well-defined Information Relationship Models (IRMs) to organize and connect diverse research elements, including samples, protocols, results, resources, and experiments. Schröder et al. (2022) demonstrated that information stored within ELNs can be translated into semantic models, enabling clearer representation of experiments and facilitating navigation across the research process.

Laboratory notebooks have long been essential to scientific practice, enabling the documentation of experiments, data, analyses, and findings (Badiola et al., 2015). However, the growing complexity of modern research has highlighted the limitations of traditional record-keeping methods such as Paper Laboratory Notebooks (PLNs), leading to the adoption of ELNs. By supporting structured data management, searchability, version control, traceability, and digital integration, ELNs improve research workflows, collaboration, and reproducibility (Dunie, 2017).

Their evolution and growing demand within scientific and academic communities reflect the shift toward digital research environments, resulting in general-purpose platforms and domain-specific solutions designed to address diverse research needs (Chen et al., 2024). These categories and their characteristics are further discussed in the following sections.

2.2 General Purpose Electronic Laboratory Notebooks

Before discussing specific platforms, it is important to distinguish between general-purpose and discipline-specific Electronic Laboratory Notebook (ELN) systems.

RSpace

RSpace[2] is an open-source research data management platform that combines an ELN with sample and inventory management, making it easy for scientists and research teams to capture, organize and share data in a FAIR compliant way. Its intuitive interface allows users to record experimental data, link samples, and materials to protocols and documents, including seamless collaboration with automatic sharing, backups, and audit tracking (RSpace, 2026).

RSpace connects with external resources, uses persistent identifiers (PIDs) to track data, and simplifies workflows from active experiments to long-term archiving. In RSpace, cloud and on-premise deployment options enhance usability by supporting data interoperability,

[2] RSpace: https://www.researchspace.com/

reproducibility, and compliance with research standards across research institutes and academia (RSpace, 2026).

University of Florida, inspired by academic institutions, such as Harvard, University of Nebraska, TU Delft, and University of Edinburgh, decided to select electronic laboratory notebook (ELN) RSpace as a platform, to improve research workflows and usability for scientists. RSpace provides an intuitive and centralized platform, to record experimental data, manage samples, link protocols, and collaboration.

RSpace features and controlled data sharing simplify day to day tasks, reduce errors, and enhance transparency, allowing researchers to focus on science rather than administrative work. The platform's integration with existing tools and its clear, user-friendly interface support efficient data organization, collaboration across labs, and reproducible research practices, demonstrating how usability driven design can enhance the overall research experience in academic institutions (Smith II, 2023).

Similarly, at a research-intensive university in the Southeastern United States, ELN RSpace was evaluated to identify the features and functionalities; researchers require to manage both open and sensitive data effectively. In addition to supporting the organization and documentation of research activities, RSpace enables institutions to assess and mitigate risks related to data security and potential breaches.

Its adoption across disciplines such as Biology, Chemistry, Life Sciences, Engineering, and Biotechnology highlights the importance of key usability features, including an intuitive user interface (UI), streamlined workflows, collaboration tools, protocol templates, laboratory inventory management, and principal investigator (PI) functionalities. These features contribute to efficient, secure, and reproducible research practices (Smith II, 2023).

In the similar case study, the Institute of Pharmacology and Toxicology at the University Medical Center Göttingen (UMG), Germany, implemented a (RDM) infrastructure centered on ELN RSpace, integrated with Laboratory Information Management System (LIMS) and Scientific Data Management System (SDMS), to enhance data management, traceability, reproducibility, and usability for complex cardiac tissue engineering experiments.

Acting as a central interface, the RSpace enabled researchers to efficiently document workflows, store detailed metadata, plan experiments, and share results in a FAIR-compliant manner. Whereas the integration with LIMS and SDMS ensured that both manual and automated laboratory processes are seamlessly captured and connected, creating a flexible, user-friendly system that can be adapted for other biomedical research laboratories respectively (Suhr et al., 2019).

LabArchives

LabArchives[3] is a cloud-based electronic laboratory notebook (ELN) that allows researchers and students to securely record, organize, and share experimental data digitally. Unlike traditional paper notebooks, it provides searchable, time-stamped records with version control, improving reproducibility and compliance in research. The platform supports collaboration, letting teams work together in real time while controlling access permission (LabArchives, 2026).

LabArchives integrates files, spreadsheets, and instrument data, to manage all aspects of an experiment in one place. Widely used in universities, biotech, and pharmaceutical labs, LabArchives streamlines research documentation and enhances data management efficiency (LabArchives, 2026).

The “TeamProject” (Technology Enhances Assessment Methods) is a nationally funded, multi-institutes initiative involving four colleges, academic staff and 1600 students, aimed at improving assessment in science and health practical sessions through digital technologies. The main focus of the ‘TeamProject’ was evaluating Electronic Lab Notebooks (ELNs), such as LabArchives, to understand their potential in enhancing student learning and supporting staff workflows.

This project’s pilot studies and surveys revealed strong student interest, with 73% to use ELNs citing benefits such as searchability, data backup, remote access, and access to instructor feedback. Whereas, staff feedback also indicated support for transitioning from manual notebooks to digital platforms (Bree et al., 2020).

Similarly, in the following study, the implementation of ELN LabArchives is examined in a molecular biology laboratory course involving 384 students over two years, focusing on molecular cloning and protein expression experiments. The research highlights that the usability of ELNs enhances how easily and efficiently users can manage laboratory data, compared to traditional paper lab notebooks, which can be lost or damaged.

This study demonstrates that students were able to digitally record procedures, attach media, generate reports, and collaborate with instructors, and gain hands-on experience with data management. While some students were initially apprehensive or found certain interface aspects challenging, the majority preferred ELNs, including teachers, due to ELN’s real-time collaboration and feedback features (Chen et al., 2024).

Also, in a ‘Bioprocess Engineering Laboratory’, it is observed that LabArchives enhances usability, workflow efficiency, and data management compared to traditional paper notebooks. It

[3] LabArchives: https://www.labarchives.com/

allowed students to draft protocols, enter raw data, and review real-time feedback, to streamline documentation, and reinforce Good Documentation Practices (GDP) (Riley, Hattaway and Felse, 2017).

Taken together, these studies demonstrate that integrating ELNs into both teaching and research environments can significantly enhance usability, workflow, data management, and collaboration. These studies highlight ELNs growing importance and adoption across academic and biomedical institutions respectively.

2.3 Domain-Specific Electronic Laboratory Notebook

Chemotion

Chemotion[4] ELN is an open-source electronic laboratory notebook specifically designed for chemists and chemistry research. It was developed to integrate (RDM) into everyday laboratory practice and includes features that support structured and efficient documentation of chemical experiments (Chemotion, 2026).

Chemotion includes tools for drawing molecular structures, planning reactions, and linking to external chemical databases, all within the same environment. These features reduce the need to switch between applications, streamlining the workflow and improving efficiency. Data can be exported or imported in standard formats, facilitating collaboration and integration with other systems.

Customizable access rights allow teams to share information safely while maintaining control over sensitive data (Tremouilhac et al., 2017). Thus, Chemotion ELN, with the LablMotion extension, provides an intuitive platform for organizing complex experimental data. Its hierarchical structure and customizable workflows make documentation clear and flexible, while community-driven extensions and ontology integration enhance collaboration, interoperability, and reproducibility (Lin et al., 2025).

Similarly, Chemotion ELN enhances usability by integrating ontologies such as RXNO and CHMO to organize and classify chemical reactions, improving data consistency, searchability and reuse in line with FAIR principles (Strömert et al., 2022). Its internal sharing functions, permission system and cross-ELN interoperability through ELNdataBridge further support efficient collaborative workflows within and across research groups (Fink et al., 2022; Starman et al., 2024).

[4] Chemotion: https://chemotion.net/

Open-source electronic laboratory notebook (ELN) Chemotion enhances usability by organizing synthetic and analytical data with embedded ontologies, DOIs, and metadata. It makes it is easy for researchers to search, visualize, and reuse information by using features like reviewing functions, embargo settings and so on (Tremouilhac et al., 2020).

Chemotion ELN, as a domain-specific solution, ensures data preservation and transparency in chemistry research, supports open data practices and enhances usability in chemoinformatics workflows respectively (Tremouilhac et al., 2020).

OpenBIS

Open Biology Information System [5](OpenBIS) is a broad open-source software, designed for RDM and widely used as an electronic laboratory notebook and laboratory information management system. It is developed by the scientific information technology (IT) services at Eidgenössische Technische Hochschule (ETH) Zurich to support scientific domain, such as Life Sciences and Biology (OpenBIS, 2026)

OpenBIS system consists of a robust core and a flexible framework layer. It provides powerful annotation services with structured project organization for experiments and datasets, comprehensive data provenance tracking, user authentication and authorization, as well as secure reproducibility, and long-term data stewardship across research projects (Tremouilhac et al., 2017).

OpenBIS supports usability through its web-based graphical user interfaces (GUIs) built on well-defined Application Programming Interfaces (APIs), providing researchers with intuitive and streamlined access to data management, analysis, and laboratory workflows. Its flexible architecture allows customization of domain-specific workflows such as:

- Next Generation Sequencing.
- High Content Screening.
- Quantitative Imaging.
- Mass Spectrometry.

OpenBIS workflows allow users to interact with data structures and processes that are aligned with users' scientific practices. OpenBIS seamless integration with external tools and automation systems, enhance workflow efficiency and accessibility for both researchers and developers respectively (Tremouilhac et al., 2017).

In a CO_2 hydrogenation case study, OpenBIS managed 59 files from 144 catalysts, including synthesis parameters, reaction conditions, and analytical results. By structuring data within

[5] OpenBIS: https://openbis.ch/

project-based workflows, and supporting API-assisted uploads, OpenBIS enabled secure access, traceability, and error reduction, demonstrating its usability in handling large, complex catalysis datasets (Lam et al., 2025).

Following the discussion of general-purpose and domain-specific ELNs, the following section presents a comparative analysis of selected ELN platforms, evaluating their approaches to research data management and support for laboratory workflows.

2.4 Electronic Laboratory Notebooks Comparison

A significant shift within the academic and scientific community towards the adoption of ELNs (Smith II, 2023) has prompted the development of a variety of ELNs, including 'Domain-Specific' and 'General-Purpose' solutions. Such digital solutions not only streamline data management and support seamless team collaboration through their features but also provide structured documentation, secure storage, and efficient organization, collectively enhancing workflow efficiency and the reliability of data handling.

The increasing volume of electronically generated data and protocols have further driven many laboratories to adopt ELNs, which makes data easier to record, search, share, and access (Chen et al., 2024). Therefore, a comparison of selected Domain-specific ELNs, including Chemotion and OpenBIS, and General-Purpose ELNs, including eLabFTW, RSpace, and LabArchives, is presented based on their key features and functionalities.

Table 1: Electronic Laboratory Notebooks Functionality Comparison

Features	RSpace	eLabFTW	Chemotion	OpenBIS	LabArchives
Open Source	Partially open-source; commercial & managed options available.	Fully open-source under GNU AGPLv3.	Fully open-source under GNU GPL.	Fully open-source under Apache 2.0 license.	Partially Open-Source
Suitability	Scales from individual users to large enterprises.	Suitable for labs of all sizes.	Flexible for both small and large research groups.	Suitable for labs and research groups of all sizes.	Suitable for Scientific Research Across Small Labs, Academic Institutions, and Large Organizations, Supporting Enterprise-Level Deployments.
Key Strengths	Robust API, digital signing, timestamped audit trails, integration with DataStore.	Timestamping (RFC 3161), full-text search, quality system EQIPD support, strong data security.	Chemical data management (structures, reactions), drag-drop UI, structure search, modular organization.	Strong LIMS integration, metadata traceability, audit trails, user-friendly organization.	Centralized Data Recording, Real-Time Collaboration, Customizable Templates, Scientific Widgets etc.
Import/Export	Supports import/export of samples, data, documents, and folders.	Export/import in XML, ZIP, PDF, DOC formats.	Supports multiple file formats via public API.	Excel/CSV import-export via templates or APIs.	Automated File Uploads from local folders, directly into notebook entries.
Ease of Use	User-friendly interface with SOP sharing, data traceability, and compliance tools.	Easy installation, customizable UI, smooth performance.	Intuitive interface for experiment generation and modification.	Automated templates for data management and sharing.	User friendly interface (UI), Multi-Device Accessibility.
Integration	Integrates with DataStore for seamless data access.	Runs on local/cloud servers; custom integrations via API.	Connects with PubChem, SciFinder, and analytical instruments.	Integrates with lab instruments and workflow pipelines via APIs.	Popular Research Softwares (i.e. SnapGene), inventory systems to reduce silos.
Database & Templates	Inventory tracking, metadata-rich documentation, customizable templates.	Comprehensive sample tracking with experiment templates.	Relational database for molecules, reactions, samples; customizable forms.	Hierarchical structure (Projects, Experiments, Datasets) with flexible data models.	Enables linked data structures, custom tags, metadata attachments, reusable templates etc.
Institutes Using	University of Edinburgh, University of Geneva, University of Bonn.	University of Jena, Technical University of Munich, Helmholtz Institute Jülich.	RWTH Aachen, Karlsruhe Institute of Technology, University of Hamburg.	ETH Zurich, Quantitative Biology Center (QBiC).	National Institute of Health (US)

Table 1, presents a comparison of five selected electronic laboratory notebooks, summarizing the diverse solutions available to meet the varied needs of research labs. For instance, RSpace offers a hybrid model with partial open-source access and commercial licensing, excelling in API integrations, digital signing, and compliance tools, making it particularly well-suited for larger institutions or enterprises that demand rigorous audit trails and regulatory adherence (Macdonald and Macneil, 2015).

Chemotion is tailored specifically for chemical research, featuring advanced data management for chemical structures and reactions, intuitive drag-and-drop experiment interface, and connectivity with analytical instruments. While highly effective within its niche, its specialized focus might limit its usefulness in multidisciplinary labs (Fink et al., 2022; Tremouilhac et al., 2017).

OpenBIS provides a fully-open source environment with strong Laboratory Information Management System (LIMS) integration and a hierarchical data structure ideal for complex project and dataset organization. This makes it attractive to labs that require detailed metadata traceability and sophisticated workflow management (Mukhin, Kazantsev and Lashin, 2023; Barillari et al., 2016).

LabArchives, a cloud-based electronic laboratory notebooks that centralizes experimental data and documentation. It offers customizable templates, real-time collaboration, audit trails, and secure data storage, ensuring integrity and compliance with standards such as General Data Protection Regulation (GDPR). Its flexibility and accessibility make it suitable for both small labs and large research organizations (LabArchives, 2026).

Lastly eLabFTW[6], a fully open-source ELN that supports laboratories of various sizes through features such as, Time Stamping, Strong Encryption, and Access Control. Its emphasis on security, openness, and flexibility, makes it a suitable solution for research groups seeking greater control over their data and infrastructure. However, compared to other ELNs, it may offer fewer specialized features and can require technical expertise for deployment and maintenance, which may limit its adoption among some users (Hewera et al., 2020).

Considering that ELN selection depends on a laboratory's workflow requirements, technical resources, and users' readiness for adoption, this research focuses on the CIIMAR case study and the implementation of eLabFTW as a digital research tool. The following subsections examine eLabFTW features and compare them with user-desired functionalities, while also discussing the recommendations of the French Committee for Open Science, the implementation of eLabFTW across European Research Institutes, and the CIIMAR case study as an example of ELN adoption within a research environment.

eLabFTW

The Electronic Laboratory Notebook (ELN) eLabFTW is a suitable digital tool for academic, industrial, and research institutions. It supports Good Manufacturing Practice (GMP) requirements, particularly in environments where digital record keeping must comply with

[6] eLabFTW: https://www.elabftw.net/

regulatory standards (eLabFTW, 2026). eLabFTW provides several features that contribute to GMP compliance, including:

- Secure and Tamper-evident electronic Record Keeping.
- Comprehensive Audit Trails.
- User Authentication and Access Control.
- Version Control of Records.
- Role-based permission management.
- Time-stamped entries.

Besides these features, eLabFTW allows users to develop digital documents of scientific work and link data acquisition with following stages such as processing, analysis and visualization. In eLabFTW, templates make routine laboratory research work easier by assisting researchers organize data in a standard, reusable format and support long-term collaboration across research initiatives. For instance, Germany's ministry of education and research, used eLabFTW, to develop knowledge graphs, improve data integration and interoperability and harmonize materials data structures (Bayerlein et al., 2024).

eLabFTW provides a range of opportunities for customization to meet the specific needs of individual research institutes. Since the digitization of research data has become a central component of modern research data management, ELNs have emerged as a foundational pillar. Platforms such as eLabFTW exemplify this advancement by incorporating comprehensive audit trail functionalities that systematically record all modifications made to original data.

This capability significantly enhances traceability, accountability, and version control compared to traditional Paper Laboratory Notebooks (PLNs) (Diederich et al., 2022). At the same time, it addresses the inherent limitations of conventional notebook use and underscores the necessity of long-term commitment from research institutions, users, and funding agencies to ensure sustainable implementation of FAIR data practices (Murphy et al., 2025).

Users Desired ELN Features and eLabFTW Functionalities.

Following the discussion of eLabFTW, Figure 1, illustrates the alignment between user desired features and eLabFTW functionalities. This comparison highlights the extent to which eLabFTW addresses key user requirements. This figure was created by the author based on the findings reported by Kanza et al. (2017)[7], which analyzed 102 ELNs across multiple disciplines, including 72 active systems while excluding 30 discontinued or acquired platforms. Kanza et al. (2017) collected feedback from researchers across various domains through surveys conducted

[7] Pearman-Kanza et al., "Electronic Lab Notebooks: Can They Replace Paper?", Journal of Cheminformatics, 9 (2017), Article 31. DOI: 10.1186/s13321-017-0221-3.

by BioSistemika and the University of Southampton to identify the most important features expected in an ELN.

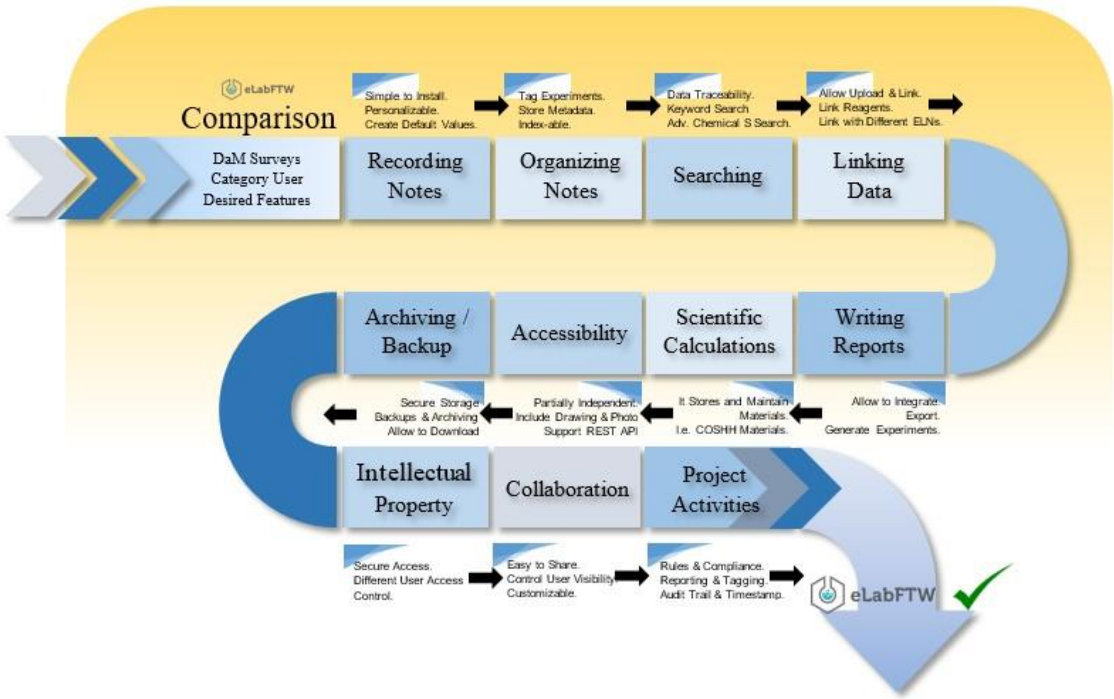

Figure 1: Comparison of eLabFTW features with User Desired Features

Based on these findings, Figure 1 presents the comparison between these user-desired features and the functionalities offered by eLabFTW, while Table 2 provides more details on how eLabFTW aligns with the identified requirements.

Table 2: Mapping of User-Desired Features Identified by Kanza et al. (2017) to Existing eLabFTW Functionalities

eLabFTW Features	**User Desired Features**
Creating "Experiments or Resources"	Recording Notes
Tags, Categorization, Comments	Organizing Notes
Data Traceability, Keyword Search, Filters	Searching
Using features "Links or Resource Links"	Linking Data
Using the Create "Experiments" option	Writing Reports
Spreadsheets Editor and Latex Equation	Scientific Calculations
Simple User Interface, Suitable for Different Scientific Disciplines	Accessibility
Allow Download/Support Secure Storage Backups and Archiving	Archiving/Backup
Secure Access and Legally Protecting Users Data	Intellectual Property
Contain "Permission Setting" feature Control User Visibility (Read and Write)	Collaboration
Support Compliance Digital Platform Integration Custom ID Audit Trail and Timestamping Bookable Resources and Categorization	Project Activities

Despite technical similarities between user-desired features and eLabFTW functionalities, many academic researchers and institutes continue to rely on paper notebooks, likely due to lack of awareness, security concerns, or resistance to change. Early experimentation with ELN platforms demonstrated interest but limited adoption. Persistent barriers including cost, ease of use, data access and compatibility remain, but their impact is gradually diminishing as digital tools become more integrated into research workflows.

French Committee for Open Science

Following the comparison between user-desired features and eLabFTW functionalities, it can be observed that eLabFTW provides a range of useful features that are well suited to the needs of research institutes. According to the French Committee for Open Science, 2021 report, several institutions including Inria, the Curie Institute, the Institute Jacques Monod, the University of Düsseldorf, and Graz University of Technology favor the open-source solution, eLabFTW.

The purpose of the report is to establish a common understanding of electronic lab notebooks (ELNs) and their functional scope, providing a methodological framework to help research teams and institutes to select the most suitable solution. The report also categorizes and evaluates several ELNs, including eLabFTW, based on their technical specifications and features.

The reason for including this study in the report is to provide in depth information about eLabFTW features. These features outlined by the French Committee for Open Science as shown in Table 3, can help research teams and institutes to improve their research data lifecycle and assess eLabFTW usability and utility respectively (Tovo Rabemanantsoa et al., 2021).

Table 3: eLabFTW features outlined by French Committee for Open Science.

Category	Technical Specifications
Data protection	Compliance with GDPR
Integrity	Ensure Versioning/Monitoring of changes
Authentication	Allows electronic signature by participants
Data Backup	Encrypt Data Transport
Confidentiality	Ensure confidentiality of exported data
Compatibility	No links with data repositories
Usage	No offline use with subsequent data synchronization means

- **Data Protection:**

eLabFTW complies with GDPR for both personal user data and research participant information, offering secure, redundant storage that meets regulatory hosting requirements.

- **Integrity and Traceability**

eLabFTW platform supports document signing, time-stamping, unique identifiers (UUIDs), version control, predefined workflows, and electronic signatures to ensure data authenticity and traceability.

- **Authentication and Security**

eLabFTW provides secure authentication with role-based access control, managing permissions according to user roles, projects and lifecycle events to protect sensitive data.

- **Backup and Confidentiality**

Encrypted data transport and storage, regular backups, and defined retention policies safeguard data availability and confidentiality, protecting sensitive and collaborative information in eLabFTW.

- **Compatibility and Interoperability**

Despite eLabFTW ensuring compatibility with various operating systems (OS) such as Windows and Linux for broad usability, the system should allow data to be managed in a structured format and facilitate integration with local information systems, such as databases and directories. Additionally, enabling links with external data repositories which is not currently supported in eLabFTW would enhance data accessibility and exchange, fostering seamless operation across different platforms and environments.

- **User Experience and Accessibility**

It is evident that eLabFTW is a user-friendly tool, and its intuitive interface is essential for effective system adoption. Features such as easy installation and updates, along with flexible modularity and customization options, enhance usability and adaptability. While eLabFTW supports multiple languages, documentation to ensure the system remains accessible and practical for diverse user communities and sustainable initiatives, eLabFTW does not offer offline capabilities, such as data synchronization respectively.

eLabFTW demonstrates strong alignment with the critical technical specifications required for effective Electronic Lab Notebooks. Its comprehensive features in data protection, integrity, secure authentication, and reliable backup ensure that research data is managed securely and efficiently. However, eLabFTW has limitations in terms of compatibility and usage, as it does not provide integration with data repositories and lacks offline capabilities. Therefore, it can be stated that eLabFTW can be considered as one of a suitable digital solution for institutions that are seeking to enhance data traceability, usability, and compliance within their research workflows.

Implementation of eLabFTW in European Research Institutes

In this section, the implementation of eLabFTW (eLabFTW, 2026) in multiple European Research Institutes, as shown in Table 4, illustrate how diverse institutions are adopting electronic lab notebooks to support Open Science and the FAIR principles. As CIIMAR plans to implement eLabFTW, these case studies provide valuable insights into the role and effectiveness of ELNs across research communities.

Table 4: Research Institutes using eLabFTW.

No	Institute Name	Location
01	The Gulbenkian Institute for Molecular Medicine	Portugal
02	GLIM-BioData Project	Portugal
03	The French National Centre for Scientific Research	France
04	CNR-IOM: STRAS Laboratory	Italy
05	TU GRAZ	Austria

Electronic Laboratory Notebooks (ELNs) have evolved significantly, from early systems like “Catalyzer” and eCAT to modern platforms such as eLabFTW (Goddard, Macneil & Ritchie, 2009). As shown in Table 4, the adoption of eLabFTW across diverse European institutions demonstrates its potential as a flexible and scalable ELN solution for research environments. Nevertheless, while eLabFTW addresses key ELN requirements, continuous evaluation and adaptation remain necessary to meet the evolving needs of multidisciplinary research communities.

Within this framework, CIIMAR is currently piloting eLabFTW as a potential institute-wide ELN solution to provide a digital platform for research documentation, improve data management practices, and enhance transparency and reproducibility in scientific research. Therefore, the following section discusses the adoption of eLabFTW at CIIMAR, focusing on its implementation, potential benefits, and challenges within the institute’s research workflows.

eLabFTW Adoption at CIIMAR

As discussed earlier, CIIMAR is undergoing eLabFTW adoption as a multidisciplinary institute comprising researchers from diverse scientific backgrounds and disciplines, each with distinct experimental procedures, resources, and documentation requirements. Unlike traditional paper laboratory notebooks, an Electronic Laboratory Notebook such as eLabFTW provides a centralized environment where experiments, protocols and inventories can be managed in a structured and searchable manner (eLabFTW, 2026).

The implementation of eLabFTW at CIIMAR[8] is carried out within the FAIRway project[9], an initiative launched in 2025 to strengthen Research Data Management (RDM) practices and advance Open Science. Among its main objectives, FAIRway aims to promote the adoption of digital tools and workflows that support FAIR principles, including the evaluation and implementation of an Electronic Laboratory Notebook (ELN). Following an initial phase of needs assessment, landscape analysis, and platform selection, the practical deployment of eLabFTW and its pilot implementation phase began in February 2026. By supporting the integration of an ELN into everyday research activities, FAIRway contributes to establishing a solid foundation for FAIR-aligned scientific processes and more efficient research data management.

In this context, the present study documents CIIMAR's institutional transition towards ELN adoption through the implementation of eLabFTW. The study involves a pilot group of researchers from different research units and follows the early stages of platform deployment, focusing on user experience, perceived benefits, challenges, and adoption factors that may influence its wider uptake across the institution.

CIIMAR's ELN implementation action plan is structured into four phases: (1)Landscape Analysis, (2) ELN Selection, (3) Pilot and Evaluation, and (4) Training and Capacity Building. This study is primarily situated within Phases 3 and 4, contributing to the assessment of usability, user acceptance, and training needs through the collection and analysis of participant feedback. As CIIMAR is currently in the pilot testing phase of eLabFTW, the findings presented here provide preliminary insights into the platform's suitability for the institutional research environment and identify key benefits, barriers, and enabling factors that may support its broader adoption in the future.

Key Benefits of elabFTW Adoption at CIIMAR

The potential expansion of eLabFTW adoption at CIIMAR is supported by a range of capabilities that align with the evolving requirements of modern research environments. Its User-Interface (UI), application design, and support for simultaneous multi-user access enhance system's accessibility and usability across diverse research teams.

In addition, functionalities such as, Experiment and Resource Link, Audit Trails, Traceability Mechanisms, Data Integrity and Access Control contribute to its suitability as a comprehensive ELN solution for research data management. These functions of eLabFTW

[8] CIIMAR's ELN implementation Action Plan official guideline: https://repositorio.inesctec.pt/server/api/core/bitstreams/502e795b-1b8c-469a-a1c8-f0b7f4aa3223/content

[9] FAIRway Project: https://www.inesctec.pt/en/projects/fairway

demonstrate its potential as an effective digital solution to strengthen research documentation, data organization, and collaborative workflows at CIIMAR.

Nevertheless, implementation within a multidisciplinary institution may involve challenges due to differences in experimental approaches, data structures, and documentation practices among research groups. As highlighted by Kanza et al. (2017), no single ELN can fully satisfy the requirements of all scientific domains. Therefore, ongoing evaluation and system adaptation are essential to ensure effective integration into diverse research workflows.

Potential Challenges of eLabFTW Adoption at CIIMAR

Despite the potential benefits of eLabFTW adoption at CIIMAR, its implementation may present several challenges. As with many research information systems, successful adoption depends not only on technical capabilities but also on user acceptance, organizational readiness, and the extent to which the platform aligns with existing research practices.

Researchers with limited prior experience using ELNs may face a learning curve when transitioning from traditional paper-based workflows. Furthermore, the customization of templates and workflows may require technical expertise that may not be equally accessible across all research groups.

Factors such as resistance to change, varying levels of digital literacy, and differences in documentation practices among disciplines may also influence user acceptance and perceived usability. These challenges provide the rationale for the present study. As eLabFTW is currently in the pilot phase at CIIMAR, understanding researchers' experiences, perceptions, and usability concerns is essential before wider institutional implementation.

Therefore, this study evaluates the platform through an online survey to obtain an initial assessment of elabFTW adoption as a supplementary component of the study, followed by User Interviews, Usability Tasks, and Post-Usability Tasks Questionnaires. The objective of this study is not to evaluate the technical architecture of eLabFTW itself, but rather to examine how researchers interact with the platform, identify usability strengths and limitations, and assess its suitability for supporting research activities within CIIMAR.

While the preceding discussion has focused on the potential benefits and challenges of eLabFTW adoption at CIIMAR, these considerations reflect broader issues associated with ELNs in general. Therefore, before presenting the main objectives of this study, it is useful to summarize the key strengths and weaknesses of ELNs to provide a broader context for evaluating eLabFTW within the institute.

Advantages and Limitations of Electronic Laboratory Notebooks

Following the discussion of the strengths and weaknesses of eLabFTW, this section presents advantages of ELNs and highlights some limitations respectively. Electronic Laboratory Notebooks (ELNs) have become increasingly important in modern research by extending beyond the digitisation of traditional paper-based records. They provide a structured environment for documenting experiments, capturing metadata, and organising research data, thereby improving data management and record-keeping practices. (Lin et al., 2025). By transforming laboratory records into structured digital information, ELNs support more consistent, accessible, and reliable documentation throughout the research process.

This structured approach also contributes to research reproducibility and supports FAIR data principles by enabling the use of standardized and machine-readable data formats (Lin et al., 2025). As a result, research data can be more easily accessed, shared, verified, and reused across different projects and scientific communities. Furthermore, modern ELNs such as “Chemotion” enhance interoperability and cross-disciplinary data reuse through structured data models and ontologies-based frameworks (Lin et al., 2025).

The integration of controlled vocabularies and ontologies promotes consistent documentation practices, allowing researchers to systematically record both successful and unsuccessful experimental outcomes (Edfeldt et al., 2024). With advances in Artificial Intelligence (AI) and Large Language Models (LLMs), the role of ELNs is expanding beyond documentation and data storage. These technologies have the potential to transform laboratory records into actionable knowledge by improving data interpretation, accessibility, and the management of complex datasets (Jalali et al., 2024).

Consequently, ELNs are increasingly becoming important foundations for supporting data-driven research and future AI-enabled scientific workflows. Although ELNs provide significant advantages for research data management, several limitations remain. Generic ELNs often offer broad applicability across research domains, however they may produce poorly structured and less machine-readable data, limiting their effectiveness for data reuse and interoperability (Lin et al., 2025).

Conversely, discipline-specific ELNs can provide more rigorous and structured documentation practices but may reduce flexibility and limit collaboration across different research fields. To maximise the benefits of ELNs, continuous community engagement, active user contribution, appropriate ontology integration, and long-term system maintenance are essential (Lin et al., 2025).

Without effective management and standardisation, issues such as inconsistent data entry, reduced data quality, and limited interoperability may arise. In addition, adequate user training is necessary to support consistent documentation practices and ensure that researchers can fully utilise ELN functionalities. Therefore, evaluating how different ELN types address these challenges through their design and functionality is important for selecting and implementing systems that effectively support diverse research environments.

2.5 Summary

Research Data Management (RDM) has become essential in modern research by supporting data organization, integrity, preservation, and reuse. The growing emphasis on Open Science has increased the adoption of digital solutions, particularly Electronic Laboratory Notebooks (ELNs), which enhance transparency, collaboration, reproducibility, and FAIR data practices. ELNs have evolved from digital alternatives to Paper Laboratory Notebooks (PLNs) into integrated platforms that support experiment, documentation, data traceability, version control, and research workflows.

While general-purpose ELNs provide flexibility across disciplines, domain-specific ELNs offer specialized functionalities for particular research fields. Despite their advantages, challenges related to usability, interoperability, training, and user adoption continue to affect successful implementation.

Among available platforms, eLabFTW has gained recognition as an open-source electronic laboratory notebook that supports secure data management, collaboration, and research transparency. Its implementation at CIIMAR through the FAIRway project aims to improve research documentation and data management practices.

However, effective adoption depends on usability, user acceptance, and alignment with researchers' needs. Therefore, the following chapter focuses on the training, testing and preliminary assessment of the eLabFTW platform, providing insights into its functionalities and practical suitability within CIIMAR's multidisciplinary research environment.

Chapter 3

eLabFTW: Training, Testing and Preliminary Assessment

In the context of the eLabFTW adoption in a research center like CIIMAR, it is important to assess the platform's usability and its potential to integrate effectively into existing research workflows. Before conducting this assessment, however it was necessary to develop a comprehensive understanding of the platform through a preliminary familiarization phase involving structured training, consultation of the official documentation, and hands-on exploration of eLabFTW.

Effective training is essential to help users fully understand and explore the capabilities of this research tool. It plays a key role in promoting accuracy, efficiency and academic integrity throughout the research process. By connecting theoretical knowledge with practical application, appropriate training enables users, including students to conduct high quality professional and reliable research. The impact of the training can be observed across several dimensions of the research process, including research efficiency, data quality, skill development and information synthesis, as outline below.

Training and Familiarization with eLabFTW

Learning a new research tool, such as eLabFTW required a structured familiarization process to gain an understanding of the platform's structure, environment, configuration and instance management. To support this learning process, CIIMAR's data management Office organized online training sessions on eLabFTW to facilitate users' familiarization with the software. These sessions provided a structured introduction to the platform and enhanced the ability to use it more efficiently and effectively, reducing the learning time associated with independent exploration through trial and error. Throughout this process, the official eLabFTW documentation guidelines were consulted to evaluate eLabFTW features and their functions (eLabFTW, 2026).

This training was undertaken to acquire practical knowledge of the research tool "eLabFTW", enable its correct use and improve the quality and reliability of data collection.

Using the eLabFTW platform enabled the acquisition of both technical and practical knowledge, as well as the development of usability-related competencies. It has also contributed to a better understanding of the digital tools and workflows commonly used in research environment.

This approach also helped to understand CIIMAR's day to day research activities carried out by researchers. It is evident that training in such tools fosters independent research capabilities, reducing the need for constant manual supervision for each technical step and enhancing both credibility and understanding of the platform, ultimately enabling the creation of "Usability Tasks" respectively.

After using the eLabFTW platform, the information gathered from different sources were combined, integrated and connected in a clear and meaningful way to develop usability tasks for participants who were new to the platform. The development of these tasks represented an important part of this thesis., as they were created to support the evaluation of eLabFTW's usability from the perspective of new users.

These usability tasks were not intended to be overly complex, rather they were carefully designed to help participants understand the learning objectives, goals, and related actions effectively. Before discussing the usability tasks, it is important to outline the constraints and challenges encountered during their development. The initial familiarization with eLabFTW was carried out through a semi-independent training approach, which combined participation in online training sessions organized by CIIMAR's Data Management Office with individual exploration of the platform and consultation of the official eLabFTW documentation.

This training phase made it possible to understand the main functionalities of the platform, including how to navigate the system, use different features, create and store data, and perform multiple actions such as creating metadata, compounds, inventory entries, primers, and chemical structures. This initial learning phase was essential for understanding the technical possibilities offered by the platform and for identifying which features could be included in the usability evaluation.

<u>Development of the Usability Tasks</u>

At the same time, it became evident that the platform needed to be considered from the researcher's perspective. In particular, it was important to identify which eLabFTW features could be useful in their day to day research activities without making the usability tasks too complex or redundant. Since the platform was new to all participants, the tasks had to be simple, accessible, and focused on useful outcomes. For this reason, the usability tasks were designed to follow a non-complex and less intensive approach, taking into account the limited ten-day timeframe available for the study.

Therefore, it was important to include relevant eLabFTW tools and features while ensuring that the usability tasks remained general enough to be suitable for all participants. This was particularly important because the participants came from different academic backgrounds and research areas. To support this process, the research paper *"Bioremediation of Petroleum Hydrocarbons in Seawater: Prospects of Using Lyophilized Native Hydrocarbon-Degrading Bacteria"* by Perdigão et al. (2021) was used as a reference and guiding resource. This paper helped structure the tasks and provided a common research context to support participants in formulating their responses.

Data collected from interviews were also used to gain a comprehensive understanding of participant's requirements and research workflows to develop the usability tasks accordingly. The complete methodology for implementing and evaluating the usability tasks is presented in Chapter 4. During this preliminary assessment and task design process, several significant constaints and challenges were encountered as presented in the following section.

3.1 Exploratory and Practical Familiarization with eLabFTW

As part of the broader eLabFTW pilot implementation at CIIMAR, all researchers participating in the experimental adoption of the platform were provided with opportunities to familiarize themselves with its functionalities through training sessions, documentation and hands-ons exploration. The activities described in this section formed part of this general onboarding process and were available both to the participants involved in this study and to other researchers participating in the institutional pilot implementation.

As the design of the usability evaluation require comprehensive understanding of the platform, it was necessary to conduct a systematic hands-on exploration of eLabFTW's features, workflows, and configuration options. This practical assessment informed the development of realistic usability tasks and ensured that the evaluation reflected authentic research scenarios' and common user interactions.

3.2 Exploratory Phase

During these sessions, an initial exploratory phase of the eLabFTW platform was carried out. This phase was conducted during the eLabFTW training process, which included online training sessions and conferences. Later on, the platform was systematically examined to gain familiarity with its interface, organizational structure, and core functionalities. Particular attention was given to the creation and management of metadata, templates, resources, experiments, chemical compounds, inventory items, and collaboration settings, including visibility and writing permissions. These components were selected because they represent essential functionalities for organizing, managing, and sharing research information within an ELN, and were therefore required for the subsequent development of usability testing for participants.

The exploratory phase began with an assessment of the overall organization of the platform and navigation through its main modules. This hands-on interaction enabled to understand how users access, create, edit, and manage laboratory records within eLabFTW. The platform documentation and built-in support resources were also consulted to clarify the purpose, workflow, and particular use of different features, including advanced functionalities. This preliminary evaluation supported the identification of relevant platform features to be considered during the usability assessment.

3.3 Practical Phase

Following this initial familiarization, practical testing was carried out by creating sample templates, resources, experiments, compounds and inventories. This practical testing allowed to simulate standardized laboratory entries and allowed the identification of available customization options, such as metadata fields, categories, tags, and file attachments.

This process helped determine how structured information could be organized within the system. After the templates were established, resources and experiments were created using the developed templates. This hands-on interaction provided a deeper understanding of the workflow associated with experiment documentation, data recording, editing, linking resources, and storing laboratory information. The process also made it possible to identify the sequence of actions required from users during normal platform operation and usability tasks. The knowledge obtained during this exploratory and practical phase served as the foundation for developing the usability tasks used in the study. By understanding the platform's navigation flow and main functionalities, realistic tasks could be designed to reflect common user interactions within eLabFTW. This ensured that the usability evaluation was aligned with authentic use scenarios and accurately assessed the effectiveness, efficiency, and usability of the platform.

eLabFTW Dashboard (Instance/Environment)

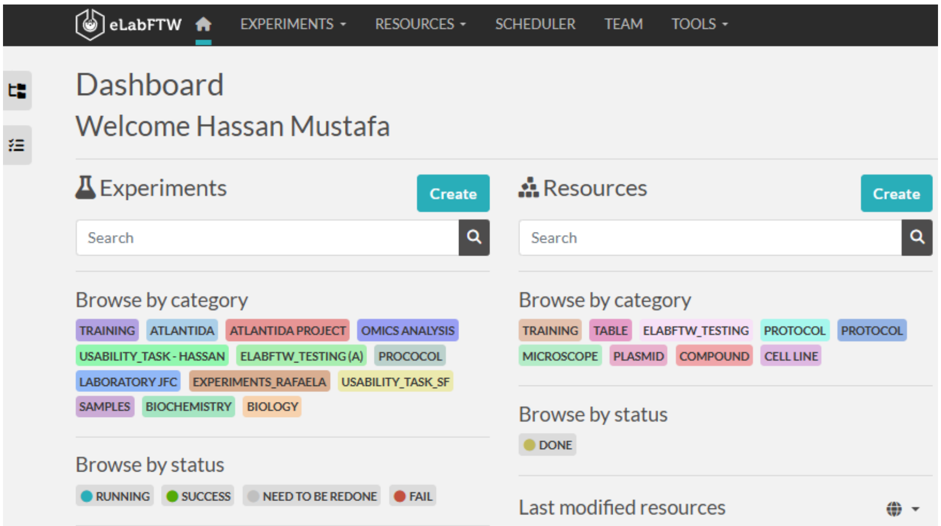

Figure 2: Dashboard Overview of eLabFTW platform.

Administrator access to the ‘CIIMAR_training’ eLabFTW instance was granted for this study, providing administrator privileges that enabled unrestricted interaction with the platform and allowed the exploration and evaluation of the platform’s functionalities during the training and testing process before designing “Usability Tasks” for participants. This level of access allowed a comprehensive exploration of the eLabFTW environment, including the dashboard as shown in the Figure 2, core features, and advanced tools available within the system.

This was essential for developing a deeper understanding of the platform’s structure, workflows, and operational capabilities. Through direct interaction with the system, it was possible to examine how different functionalities were organized and how users could perform common laboratory management activities within eLabFTW. Administrator access also enabled the creation and management of resource templates, resources, and experiments, which provided practical insight into the platform’s data organization and documentation processes.

Additionally, advanced eLabFTW tools and configuration options were explored to better understand the range of functionalities available to users with different permission levels. This process of exploration and hands-on interaction contributed significantly to acquiring the knowledge required to design realistic and representative usability tasks. The familiarity gained with the platform’s workflows and features ensured that the developed tasks accurately reflected typical user interactions and operational scenarios within the eLabFTW environment.

eLabFTW: "Categories"

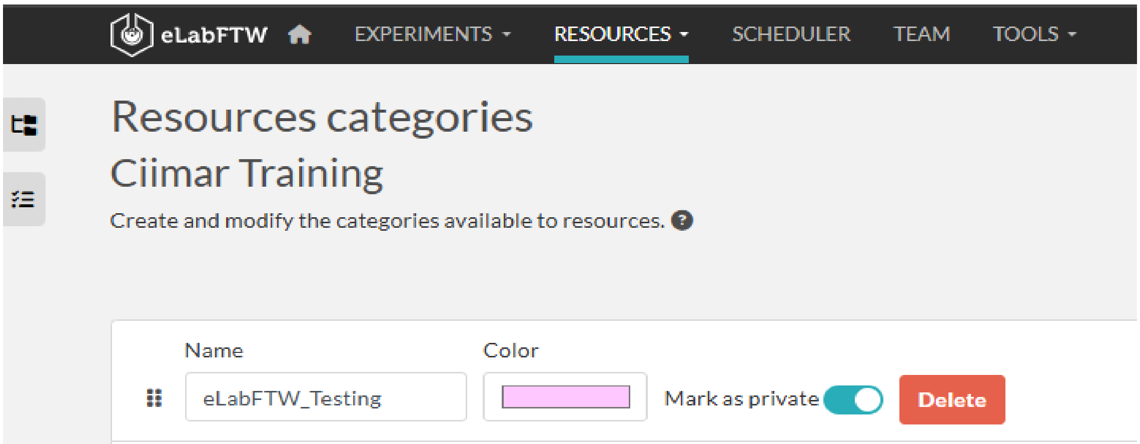

Figure 3: Categorization overview of eLabFTW platform.

During the eLabFTW training and familiarization process undertaken for this study, a resource category named "eLabFTW_Testing" was created and assigned the color pink as shown in Figure 3. This activity formed part of the initial familiarization with the platform's organizational and customization features. The use of color-coded resource categories in eLabFTW represents an organizational technique that enables researchers to classify and manage information more efficiently within the digital laboratory environment. By assigning distinct color schemes to categories, users can more easily identify, differentiate, and locate research-related materials, experiments, and resources stored on the platform.

This practical exercise provided insight into how eLabFTW supports structured data organization and enhances the accessibility and visibility of laboratory records, contributing to a more efficient and user-friendly research management workflow.

Following a similar procedure, an experiment category named "eLabFTW_Testing (a)" was created and assigned the color green before proceeding to the subsequent stages of the training process. In eLabFTW, the Resources and Experiments functionalities are accessible through separate dropdown menus; however, the process for creating and managing categories within these sections follows a similar workflow.

This similarity in structure and operation contributed to a better understanding of the platform's interface consistency and organizational design. The creation of both resource and experiment categories also demonstrated how eLabFTW supports systematic classification through the use of customized labels and color schemes, enabling users to organize, identify, and navigate laboratory information more efficiently within the digital environment.

eLabFTW: Template

After the creation of the resource and experiment categories in eLabFTW, the next stage involved the development of the first resource template using the Resources option located in the top navigation menu of the platform.

The Resources dropdown menu contains several functionalities, including My Resources, Team Resources, All Resources, Bookable Resources, Resource Templates, Resource Categories, and Resource Status. Additionally, the interface provides a search bar that enables researchers to efficiently locate the specific resource within the system.

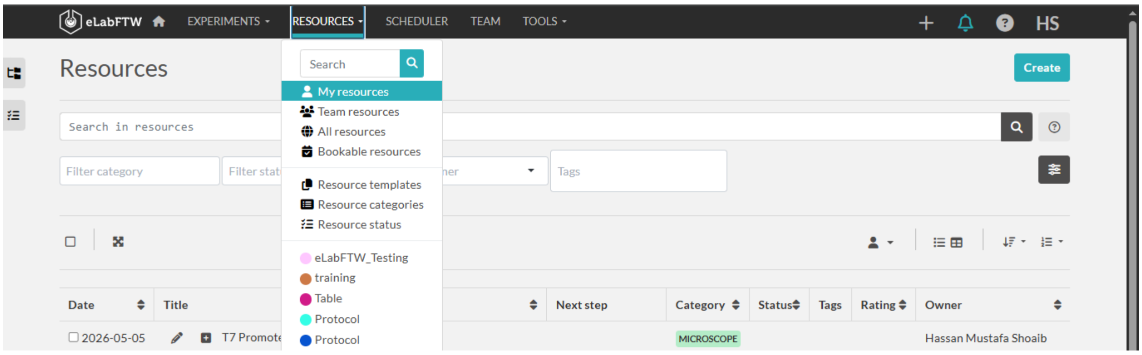

Figure 4: Creation of Resource Template overview using eLabFTW Platform

Among these functionalities, particular attention during the training process was given to Resources, Resource Templates, and Bookable Resources. Exploring these features provided practical insight into how laboratory materials, equipment, and research-related information can be structured, managed, and accessed within eLabFTW.

In particular, the creation of resource templates was especially important, as it demonstrated how standardized formats can be established for consistent documentation and organization of laboratory data. Likewise, the examination of bookable resources highlighted the platform’s capability to manage shared laboratory equipment and scheduling processes.

This hands-on exploration of the platform’s resource management functionalities contributed to a deeper understanding of eLabFTW and provided the necessary foundation for designing realistic, real-world usability tasks for the subsequent evaluation phase of the study. Following this initial exploration, the practical creation of resource templates was undertaken to gain direct experience with one of the platform’s core resource management functionalities.

After selecting the Resource Templates option from the Resources dropdown menu as shown in Figure 4, a new entry was created by choosing “Resource Template” from the available options. A title, “eLabFTW_Training_Resource-Template”, was then assigned, followed by the selection of the “Create a Resource Template” option. This process enabled the creation of the first resource template within the eLabFTW digital platform. The activity provided practical experience with the template creation workflow and demonstrated how standardized resource structures can be established within the system.

Resource templates in eLabFTW serve as predefined formats that facilitate consistent organization and documentation of laboratory-related information. They enable researchers to structure data systematically, improve uniformity across records, and simplify the process of creating new resources within the platform. This functionality is particularly valuable in supporting efficient laboratory management and ensuring consistency in research documentation practices as shown in Figure 5.

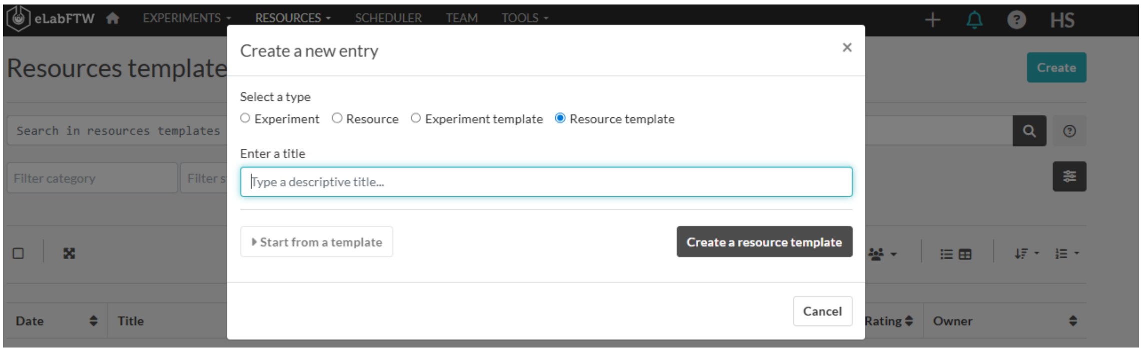

Figure 5: New Entry Creation Process in eLabFTW Platform

After clicking the "Create a Resource Template" button, the resource template was successfully generated within the eLabFTW platform. This marked the completion of the initial template creation process and enabled further interaction with the template configuration and customization features available in the system.

Following the similar procedure, an experiment template was also successfully created within eLabFTW as shown in Figure 6. The process closely resembled the workflow used for creating resource templates, demonstrating the consistency of the platform's interface and functionality across different modules.

For this task, the experiment template was titled "eLabFTW_Training_Experiment-Template". This exercise provided further familiarity with the template creation process and highlighted how eLabFTW supports the standardized organization and documentation of experimental procedures and laboratory activities.

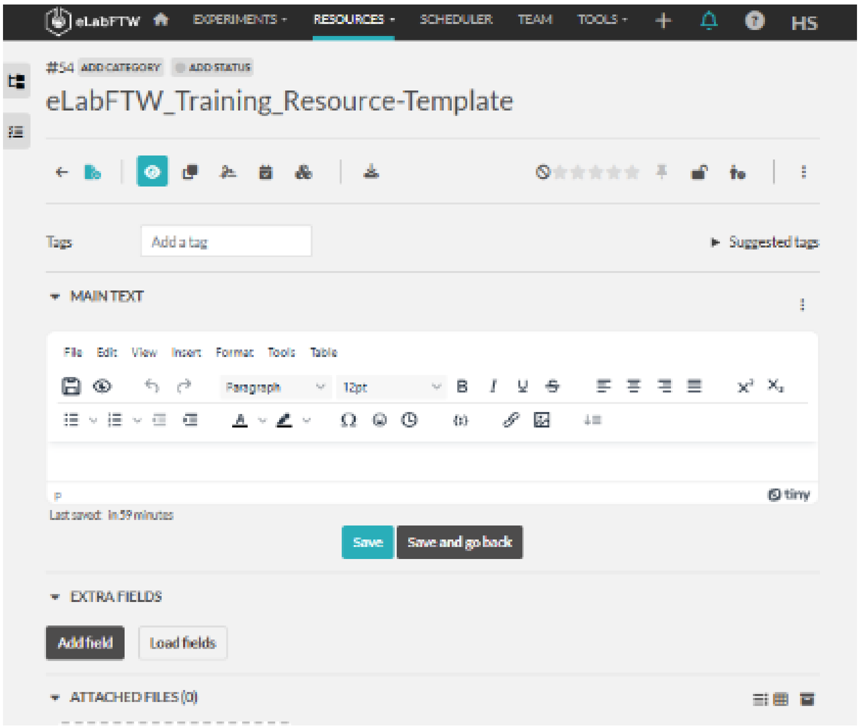

Figure 6: Creation of Experiment Template Using eLabFTW platform.

<u>**eLabFTW: “Resources” and “Experiments”**</u>

After creating the Resource Template, the next step involved creating a resource based on the previously developed template. To accomplish this, the Resources menu was accessed and the My Resources option was selected. A new resource entry was then created by clicking the Create button and assigning the title “eLabFTW_Training_Resource”. During the creation process, the Start from a Template option was selected, followed by the selection of the previously created resource template, “eLabFTW_Training_Resource-Template”. This enabled the new resource to inherit the predefined structure and settings established within the template.

Although eLabFTW allows resources to be created without the use of templates, the use of templates promotes standardization and consistency in research documentation practices. Templates facilitate the organization of information in a structured manner, reducing variability across records and improving the overall efficiency of data management within the platform.

Additionally, using template-based resource creation provided a deeper understanding of eLabFTW’s features and functionalities, particularly regarding workflow standardization, resource organization, and the practical application of predefined documentation structures within a digital laboratory environment.

After creating the resource, a similar procedure was followed to create an experiment "eLabFTW_Training_Experiment" using the previously developed template, "eLabFTW_Training_Experiment-Template". This process further demonstrated the consistency of the workflow within eLabFTW, as both resources and experiments can be generated through comparable template-based procedures.

The use of templates in experiment creation supports standardized documentation practices and ensures uniformity in the organization of experimental records. This functionality also contributed to a more comprehensive understanding of how eLabFTW facilitates structured data management and efficient laboratory workflow organization.

After creating both the resource and experiment entries, several additional features within eLabFTW were explored to develop a comprehensive understanding of the platform's functionalities. This hands-on interaction was essential for designing usability tasks based on predefined evaluation criteria. The following actions were performed during the training process:

- Categorization of the resource and experiment entries using previously created categories.
- Modification of the entry status to *"Running"* from the available status options.
- Rating of the created entries, including both resources and experiments.
- Creation of custom identifiers (Custom IDs).
- Editing of the main text content associated with the entries.
- Creation of new metadata fields for structured data organization.
- Attachment of files to entries.
- Linking experiment with related resources.
- Addition of a compound.
- Addition of storage and inventory information.
- Configuration of *visibility* and *edit/write* permissions.
- Posting comments within entries.

Exploring these functionalities provided practical insight into the operational workflow and data management capabilities of eLabFTW. It also contributed to understanding how researchers can organize, document, and manage laboratory information within a collaborative digital environment. Following the same method, another resource entry was created using the same resource template and designated as *bookable*.

This feature in eLabFTW enables resources to be reserved and scheduled for use by different users within the system. The *bookable resources* functionality supports the management of shared laboratory equipment and materials by allowing users to define availability, allocate time slots, and prevent scheduling conflicts. This contributes to more efficient coordination of laboratory assets and ensures that resources are used in an organized and traceable manner.

Using different booking parameters, as shown in the Figure 7, assisted to obtain more insights about how eLabFTW facilitates resource sharing and scheduling within a collaborative research environment.

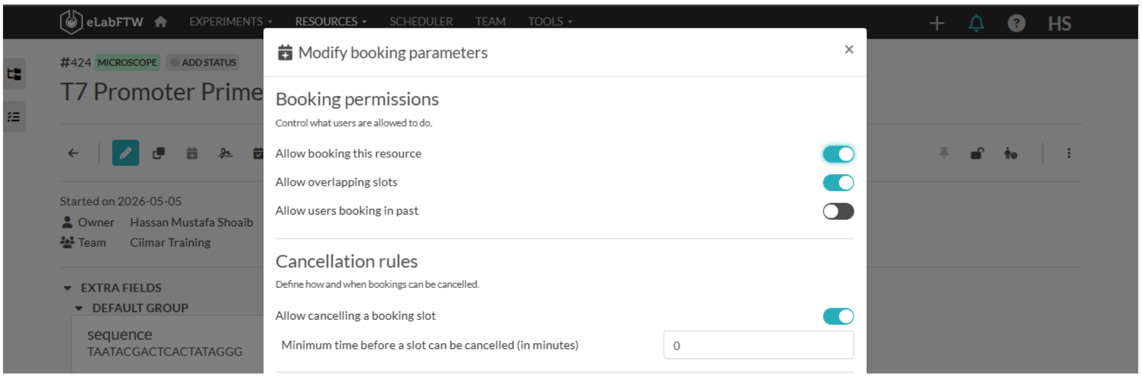

Figure 7: Overview of Booking Permission in eLabFTW platform

Functionalities related to compounds and inventory storage were explored and incorporated into the study, as these features were considered relevant to typical laboratory workflows and user interactions. Further discussion of these aspects is provided in the following section, “eLabFTW Advanced Tools.”

eLabFTW: “Advance Tools”

eLabFTW provides several advanced tools and functionalities as shown in Table 5 that were explored during the training process and later used in the development of usability tasks. These tools enabled a deeper understanding of the platform’s capabilities and supported the creation of realistic task scenarios representative of typical laboratory workflows:

Table 5: eLabFTW Advanced Features

Advance Features	Summary
Compound	The eLabFTW “Compounds” feature was explored to understand how chemical entities can be managed within the platform. The functionality allows users to store and organize chemical information, including identifiers such as CAS number, molecular formula, SMILES, InChl, and hazard-related properties. The “import from PubChem” option was tested by importing the compound *D-Glucose*, demonstrating the integration of external chemical databases into eLabFTW. The imported compound was also associated with the resource eLabFTW_Training_Resource, highlighting how chemical data can be linked with laboratory resources to support documentation, inventory management, and collaborative workflows.

Inventory	The eLabFTW advanced "Inventory" tool was explored to understand the organization and management of laboratory storage locations. A hierarchical inventory structure was created by establishing a root element (*eLabFTW_Training*) with associated sub-elements (Basement, First Floor, and Second Floor), including a further storage unit (*Fridge No. 76A*) under First Floor. The exercise demonstrated how eLabFTW uses parent-child relationships to represent physical laboratory spaces and storage units. The storage location *Fridge No. 76A* was then linked to the resource eLabFTW_Training_Resource, illustrating how inventory location can be associated with resources to improve traceability, organization, and laboratory resource management.
Chemical Structure Editor	The Chemical Structure Editor in eLabFTW was explored to understand its capabilities for creating, visualizing, and modifying chemical structures such as drawing simple molecule, adding functional groups, searching similar structures using the tool and exploring molecule and macromolecule modes.
Open Cloning	The Open cloning tool was explored to understand its features for planning and designing DNA cloning experiments. The task included adding primer sequences, saving them to eLabFTW, and interacting with available cloning-related functions.

During the eLabFTW training, the various options and features of the platforms were systematically explored to develop a comprehensive understanding of its functionality and structure as shown in Table 6, despite some constraints and challenges as shown in Table 7, during eLabFTW platform training.

This included core components such as experiments, resources, inventory management, compounds and advanced features like the Open Cloning tool and the Chemical Structure Editor. The training provided both theoretical and practical knowledge of how these features are used to document, organize, and manage research data within a laboratory environment.

It also helped in understanding how different modules interact within the system to support complete research workflows. Based on this acquired knowledge, usability tasks were designed and developed to reflect realistic research scenarios. These tasks were structured to evaluate how effectively users can apply the platform's features in practice and to assess its usability within a scientific research context.

3.4 Learning Outcomes from eLabFTW Training

Table 6: eLabFTW Training Outcomes.

Features		
01	Templates Layout	Structure used to standardise experiments and resources.
02	Resource	Management of laboratory materials, samples, and equipment.
03	Experiment	Core module for documenting and organizing research work.
04	Storage	System for managing and tracking physical storage locations and items.
05	Compound	Inventory feature for recording chemical substances and mixtures
Advanced Features		
01	Open Cloning	Tool for designing and planning DNA cloning experiments.
02	Chemical Structure Editor	Tool for drawing and visualising chemical structures.

3.5 eLabFTW Platform Training Constraints and Challenges:

Table 7: eLabFTW Training Challenges and Limitations.

Lack of scientific knowledge:	Limited prior scientific background restricted deeper understanding during the study.
Basic use of eLabFTW features:	eLabFTW functionalities were used only for basic purposes.
Limited ability to evaluate complex research structures:	There was insufficient training to assess eLabFTW features in relation to complex experimental designs and research workflows.
Insufficient expertise in advanced tools:	No adequate training was received to gain proficiency in tools such as Open Cloning and the Chemical Structure Editor, which limited the ability to create moderate to advanced usability tasks.

Limited exposure to diverse research domains:	Training did not cover a broad range of scientific research areas, thereby restricting the development of diverse usability tasks and limiting a deeper understanding of the broader applications of eLabFTW features.

3.6 Online Survey: A Preliminary Assessment of eLabFTW Community

Following the training and hands-on testing of the eLabFTW platform, an online survey was developed and distributed to eLabFTW users to gather preliminary insights into the platform's usability across international research institutions. Although this survey was not included in the original dissertation research design, it was independently conducted by the author as an exploratory assessment of the platform. The purpose was to examine user experiences, explore key features of eLabFTW, and identify perceived benefits and challenges associated with its implementation in different research contexts. The survey comprised seven questions designed to assess the following aspects:

- Institutional Context.
- Duration of Use.
- Research Domains.
- Data Types Managed.
- User Satisfaction.
- Implementation Challenges.
- Perceived Benefits.

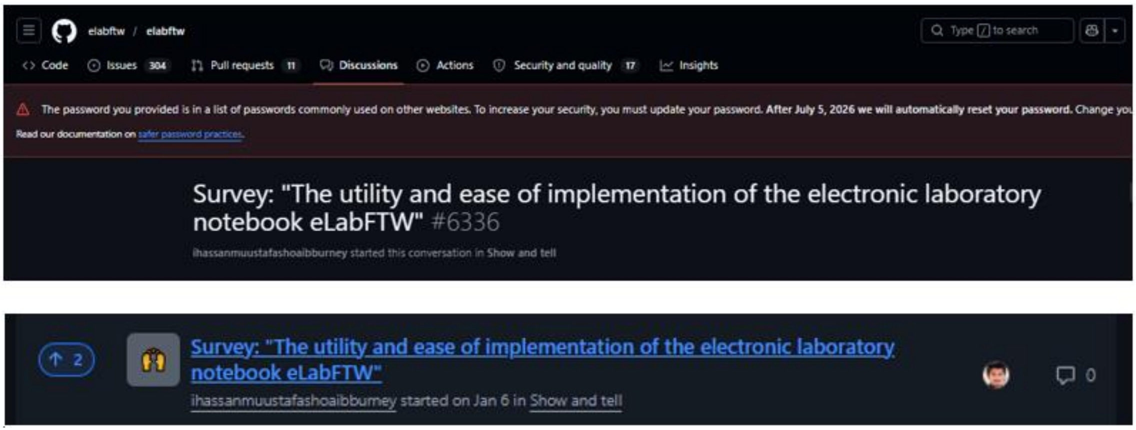

Figure 8: eLabFTW Preliminary Assessment Survey Form shared on GitHub Community.

To maintain participants' confidentiality, no personally identifiable information was collected. The survey was open from January 2026 to April 2026 and was distributed through the eLabFTW community on GitHub[10] and the Gitter[11] chat room, as shown in the Figure 8 to encourage participation, the survey was reposted weekly throughout the data collection period. A total of ten responses were received, and the results are presented and discussed in the following sections.

Online Survey Methodology

The survey was designed to collect both quantitative and qualitative data through demographic and experimental information related to the adoption and use of eLabFTW in research institutions. It consisted of seven questions: 5 short-answer questions, 1 open-ended question, and 1 rating-based question. This combination of question types enabled the collection of both contextual information and user perceptions regarding the platform's adoption and usability.

The survey questions Appendix B, were designed to collect information on the institutional context, user experience, and perceptions of eLabFTW. The questionnaire gathered information on respondents' institutions, geographical location, duration of platform use, and research fields, providing context for understanding the adoption of eLabFTW across different research environments. It also included a five-point Likert scale question to assess overall user satisfaction with the platform.

In addition, two open-ended questions explored the main challenges encountered during eLabFTW implementation and the perceived benefits of using the platform. These qualitative responses complemented the quantitative findings by providing insights into users' experiences, perceived strengths, and implementation barriers. Together, the survey responses contributed to a preliminary understanding of eLabFTW adoption, usability, and its suitability for supporting research data management practices across different research settings.

Online Survey Results and Findings

The responses represented a diverse group of users from academic and research organizations across Germany, France, Canada, the United States, the United Kingdom, and South Korea. Participants reported experience with eLabFTW ranging from a few hours to four years, reflecting different stages of adoption, from initial testing to established institutional implementation.

Participants also represented a broad range of scientific disciplines, including chemistry, biochemistry, cancer research, toxicology, physics, microbiology, and other life science fields.

[10] https://github.com/elabftw
[11] https://app.gitter.im/#/room/#elabftw_elabftw:gitter.im

The types of data managed through eLabFTW varied widely, including experimental records, analytical instrument data, simulation outputs, microscopy data, computational files, and laboratory documentation. This diversity demonstrates the flexibility of eLabFTW in supporting different research workflows and data types.

When evaluating their overall experience with eLabFTW, respondents expressed positive experiences, particularly regarding the platform's flexibility, searchability, traceability, and support for collaborative research workflows. However, variations in ratings suggest that user experience can depend on factors such as implementation approach, familiarity with ELNs, and institutional requirements.

Regarding implementation challenges, participants highlighted several technical and organizational barriers. Common concerns included limitations in user interface design, template flexibility, infrastructure scalability, and the ability to enforce structured and machine-readable data entry. Other challenges involved encouraging researchers to transition from paper-based workflows, establishing institutional policies, ensuring user acceptance, and addressing requirements for official or regulatory recognition of ELN records.

Despite these challenges participants identified several significant benefits of using eLabFTW. The most frequently reported advantages included centralized data management, improved searchability, enhanced traceability, and easier collaboration between researchers. Participants also appreciated the platform's flexibility across different research fields and its ability to support standardized digital documentation aligned with FAIR data principles.

Overall, the survey findings indicate that eLabFTW provides valuable support for modern research data management, while successful adoption requires continuous improvement in usability, infrastructure, and alignment with diverse researcher needs.

3.7 Summary

This chapter presented the training and practical exploration of eLabFTW as part of its adoption at CIIMAR. The training provided essential knowledge of the platform's structure, workflows, and functionalities to support the development of usability tasks.Using the CIIMAR_training instance with administrator access, key features including resources, experiments, templates, metadata, inventory, compounds, and selected advanced tools were explored.

The process demonstrated eLabFTW's ability to support structured research documentation, data management, and workflow organization, while also identifying limitations related to advanced features requiring specialized knowledge. The acquired experience enabled the design of realistic usability tasks focused on essential research activities and accessible interactions for new users.

Additionally, a preliminary online survey gathered insights from users' at international research institutes with experience in eLabFTW adoption, highlighting benefits such as improved organization, traceability, collaboration, and data management, as well as challenges related to user adoption and system adaptation.

Overall, this chapter established the practical foundation for the usability evaluation methodology presented in the following chapter.

Chapter 4

Research Design and Methodology

Following the discussion on eLabFTW platform training and testing, as well as the preliminary assessment of eLabFTW, this study further employed a two-phase methodology to address its primary objectives and evaluate the potential adoption and usability of eLabFTW within the CIIMAR research environment.

The first phase focused on understanding participants' existing data management practices, laboratory workflow, and documentation challenges. A semi-structured interview protocol was developed through an iterative process involving the dissertation supervisors, with multiple rounds of review and refinement to ensure alignment with the research objectives. Prior to data collection, an informed consent form was prepared to ensure that participants were aware of the study objectives, procedures, and data handling practices.

Following the approval of the research instruments, four semi-structured interviews were conducted between 12th and 27th March, 2026. Three semi-structured interviews were carried out in person at CIIMAR, while one interview was conducted online. The average interview duration was approximately 40 minutes. Throughout the data collection process, careful attention was given to maintaining an appropriate interview environment that ensured research ethics, participant privacy, and a professional atmosphere.

The interviews explored participants' current laboratory practices, limitations, and requirements related to research data management. The collected responses were recorded with participant consent, transcribed, coded, and analyzed to identify key themes that informed the subsequent usability evaluation phase.

An informed consent form Appendix **C**, was provided to all participants prior to the interviews, covering all stages of participation in the study, including the semi-structured interview sessions, usability tasks, and post-usability tasks questionnaire.

An "Awareness" assessment was developed during semi-structured interview transcription to evaluate participants' familiarity and engagement with key data management concepts such as: Electronic Laboratory Notebooks (ELNs), Metadata, Data sharing, Reproducibility, Use of Digital tools and Contamination risks.

Based on the findings from the semi-structured interviews, usability tasks were designed and implemented. These tasks were developed to represent realistic laboratory scenarios and evaluate user interaction with eLabFTW functionalities, including data organization, resource management, and documentation workflows.

Usability tasks were deployed on the eLabFTW training environment as an admin, and distributed to the group of participants in May 2026. Participants were initially given ten days to complete the tasks, with an extension provided to accommodate workload-related constraints.

Following the completion of the usability tasks, participants were invited to complete a Post-usability tasks questionnaire designed to gather additional feedback regarding their experiences with eLabFTW. This questionnaire aimed to compliment the findings collected during the usability activities and provide further insights into participants' overall impressions of the platform.

Lastly, all results obtained from primary and supplementary objectives of this study, were analyzed to identify user experiences, challenges, and perceived benefits associated with eLabFTW. These findings were used to support the final assessment of eLabFTW's usability, effectiveness, and suitability within the CIIMAR research context.

4.1 Study Participants

On February 6, 2026, the thesis workflow was presented at CIIMAR in the scope of a laboratory meeting, to formally introduce the study and outline the planned data collection procedures. This initial presentation aimed to familiarize the researchers with the study's objectives and methodology, while also establishing communication and collaboration with potential participants within the CIIMAR research environment. Following the presentation, four researchers volunteered to participate, which facilitated the subsequent scheduling of interviews to evaluate their current research data management practices.

Participants were identified using anonymized codes to protect their identity and ensure confidentiality throughout the study. Each code was assigned to a specific participant and used consistently in all interview records, transcriptions, usability task notes, and analysis files. For example, the code "P/R.M-0.01" refers to one participant without revealing any personal or identifiable information. This coding system allowed the data to be organized and analyzed while maintaining participants' privacy.

"**P/M.M-0.04"**, requested to give an online interview due to work commitments and after completing the interview and a portion of the usability tasks, the participant withdrew from the study because of ongoing work-related commitments. During the online interview, participant **P/M.M-0.04** audio was not recorded, therefore participant **P/M.M-0.04** agreed to record the entire meeting and provide the transcription in the end. Online interview transcription was generated by **P/M.M-0.04** using AI-tool, therefore the entire transcription was analyzed carefully to maintain transcription authenticity, without losing any data. Following the completion of the interview, participant **P/M.M-0.04** withdrew and did not participate in the subsequent phases of the research.

All the semi-structured interviews were recorded using the cell-phone, and to change the audio extensions from AAC to MP4, website 'FreeConvert'[12] was used. Lastly, to protect participants' privacy, all individuals' names and identifying information were anonymized throughout the study. This systematic process ensured the integrity of the collected data while enabling a comprehensive understanding of participants' current practices. The following sections provide a detailed demographic overview of the participants involved in this study.

4.2 Participants Demographic Information

A. The participant **P/R.M-0.01**, member of the Investigation Team, is a researcher affiliated with "EcoBioTec" research group at CIIMAR (Interdisciplinary Centre of Marine and Environmental Research), with expertise in bioremediation, microbial applications, sustainability, environmental chemistry, and recovery.

B. The participant **P/J.C-0.02**, member of the Research Team, is a PhD-qualified researcher at CIIMAR (Interdisciplinary Centre of Marine and Environmental Research) providing specialized scientific expertise in microbiome ecology and biogeochemistry.

C. The participant **P/S.F-0.03,** member of the Research Team, holds a BSc in Biology (2011), an MSc in Toxicology and Environmental Contamination (2013), and a PhD in Biology (2023) from the Faculty of Sciences, University of Porto. The participant is currently a research technician at the CNP laboratory at CIIMAR, with expertise in microalgae cultivation, natural product discovery, and structural characterization. Participants hold extensive experience in various chromatographic, spectrometric, and spectroscopic techniques. Furthermore, the participant currently serves as manager of the CNP laboratory, being responsible for the development and maintenance of standard operating procedures (SOPs), management of equipment and consumables, implementation of safety and quality protocols, and promotion of good laboratory practices (GLP).

D. The participant **P/M.M-0.04**, member of the Research Team, holds a degree in Biochemistry (1997) from the University of Lisbon (Portugal) and a PhD in Plant and Microorganism Biotechnology (2003) from the University of León (Spain). The participant

[12] https://www.freeconvert.com/

conducted postdoctoral research in Spain, France, and Portugal. Since 2007, the participant has led a research team at IBMC/i3S. The participant has served as an Adjunct Assistant Professor at the Faculty of Sciences and at ICBAS (University of Porto) and, in 2025, joined CIIMAR as a Principal Investigator. Throughout the participant's career, primary scientific focus has been on the molecular mechanisms regulating secondary metabolite production in Actinobacteria. Currently, the participant's research aims to translate knowledge of secondary metabolism into innovative biotechnological strategies for the discovery and production of natural products.

4.3 Semi-Structured Interview Framework

Following the discussion of the participants' selection process and their demographic information, a semi-structured interview guide was developed Appendix D. This interview was organized into six sections: **Demography**, **Documentation Practices**, **Research Data Access and Control**, **Data Management Practices**, **Collaborative Work Practices and Information Sharing** and lastly, **on the Adoption of ELNs**. Each section comprised primary questions complemented by several follow-up questions, allowing for a more in-depth exploration of participants' experiences, practices, and perspectives.

Section: Demography

The demography section was designed to provide an overview of the participants' professional background, current roles at CIIMAR, and the nature of the research activities they perform. This section included one primary question and two follow-up questions aimed at understanding participants' responsibilities, research domains, and typical experimental workflows. Additionally, it explored how participants organize and conduct their experiments or studies, as well as the types of data they generate, manage, and analyze throughout their research activities.

Section: Documentation Practices

The documentation practices section focused on understanding how researchers at CIIMAR currently document their experiments and research activities. Four primary questions and eleven follow-up questions were developed to explore the tools, approaches, and procedures adopted by participants for research documentation. Participants were asked whether they rely on physical laboratory notebooks, digital tools, or a combination of both, and were invited to describe their current documentation practices, including aspects they consider effective and areas where improvements may be required.

This section also examined whether participants follow formal documentation procedures and whether these practices are individually established or collectively defined within their research teams. Furthermore, participants were asked about the types of information they typically record to support the interpretation, understanding, and reproducibility of experimental data. As this question was considered sufficiently direct and self-explanatory, no additional follow-up questions were developed. Finally, participants were encouraged to reflect on the challenges associated with manual documentation practices, including time constraints, missing information, inconsistencies, and difficulties in reproducing previous experimental work.

Section: Research Data Access and Control

The Access and Control section aimed to explore participants' perceptions and practices regarding research data accessibility, security, and control. Five primary questions were developed, with follow-up questions included where additional clarification was considered necessary. Participants were first asked who currently has access to their research data and whether their existing documentation practices provide an adequate sense of security and control over their records.

Similarly, participants were asked whether they considered their current data management practices to be secure. As these questions were considered sufficiently direct, no follow-up questions were included. To further investigate data access management, participants were asked their perspectives on different levels of access permissions, such as read-only access, editing rights, and administrative privileges, similar to those available in electronic laboratory notebook (ELN) systems such as eLabFTW.

Participants were also asked how these permissions are currently managed within their existing workflows. These questions aimed to explore not only who can access research data but also how access rights are structured and maintained. In addition, the section examined who is responsible for controlling data access and what measures are currently implemented to prevent data loss or unauthorized access. Overall, these questions were designed to assess the access and control dimensions of participants' current research documentation and data management environments.

Section: Data Management Practices

The Data Management Practices section explored the strategies, tools, and approaches participants use to organize, record, and maintain their research data. Seven questions were developed to examine current data management workflows, including the use of PLNs, Microsoft Word, Microsoft Excel, shared drives, and Laboratory Information Management Systems (LIMS).

Participants were asked whether they record experimental information digitally or on paper, and whether their notes tend to be detailed or concise. These questions aimed to understand participants' experiences with their current documentation systems, including both advantages and limitations. Follow-up questions were used to further explore positive aspects, challenges, and potential areas for improvement.

The section also examined how frequently participants revisit previous experiments and whether their documentation remains clear, understandable, and useful over time. These questions were intended to evaluate the long-term accessibility and interpretability of research records. Furthermore, participants were asked about their familiarity with the concept of metadata and how they would define it, allowing an assessment of their understanding of structured information and its role in improving research documentation.

To further investigate data recording practices, participants were asked about the types of information considered essential for interpreting experimental outcomes. Examples included schematic representations, textual annotations, experimental records, workflow descriptions and tags. Finally, participants were asked how they ensure that their documentation remains consistent, complete, and reliable over time. This question aimed to identify the strategies researchers currently employ to maintain the quality, continuity, and usability of their research records.

Section: Collaborative Work Practices and Information Sharing

The Collaborative Work section examined how researchers collaborate, share information, and coordinate activities within and beyond their research teams. Four questions were developed to explore participants' experiences with collaborative practices, including similarities and differences between their own approaches and those of their colleagues.

Participants were asked at which stages of the research process collaboration most frequently occurs, such as during experimental planning, data collection, experimentation, or analysis. The section also investigated the methods used to share research information, including USB devices, email, shared drives, external storage devices, and laboratory management software.

Additionally, participants were asked what types of information they consider essential for ensuring that experiments can be reproduced by other researchers and for supporting effective collaboration. Finally, the section explored how participants collaborate in practice, including interactions within their immediate research groups and with other teams or departments at the institute.

Section: On the Adoption of ELNs

The Future Improvements section represented the final component of the semi-structured interview script and aimed to capture participants' perspectives regarding potential enhancements to their current documentation and data management practices. This section included a combination of closed-ended and reflective questions designed to explore participants' willingness to adopt new approaches and the factors that may influence future changes.

Participants were asked whether they had previously considered changing the way they document their research activities and what motivation or barriers might encourage such changes. Finally, participants were invited to share their perceptions of electronic laboratory notebooks (ELNs). They were asked about their familiarity with ELNs and encouraged to discuss their expectations, opinions, and views regarding the potential adoption of ELN systems within research environments.

4.4 Usability Tasks

Following the completion of the eLabFTW training sessions and semi-structured interviews, the thesis author developed a set of usability tasks within the eLabFTW training environment Appendix E, acting in the administrator role. Participants were subsequently asked to complete these tasks to gain hands-on experience with the platform and to support the evaluation of its usability and suitability for research documentation activities.

This included participant P/M.M-0.04, who eventually withdrew from the study due to work commitments after completing the interview and was therefore unable to participate in the usability tasks or the post-usability questionnaire. These usability tasks were developed directly within the eLabFTW environment and were intended to simulate common laboratory documentation and data management activities.

Participants were asked to complete these tasks in order to gain hands-on experience with eLabFTW and evaluate its suitability as a potential alternative to traditional paper-based laboratory notebooks. Once the tasks had been prepared, an invitation email was sent to all participants on 6 May 2026, providing access to the eLabFTW training environment together with instructions for completing the tasks within a 10-day period.

A follow-up reminder was sent on 15 May, informing participants of the approaching deadline and offering an extension until 18 May if additional time was required. Both communications emphasized the importance of participant feedback and acknowledged their contribution to the study.

Usability Tasks Framework

Within the eLabFTW system, a predefined experiment titled "Usability Tasks Test Sheet" was created to organize the activities. This experiment provided participants with a brief overview of the usability tasks, enabling them to understand the overall purpose and workflow before proceeding to the subsequent sections.

In the "Exercise Instruction" section, participants were given some necessary instructions and guidelines before starting the usability tasks. The instructions included using the provided research article as a reference *"Bioremediation of Petroleum Hydrocarbons in Seawater: Prospects of Using Lyophilized Native Hydrocarbon-Degrading Bacteria"* (Perdigão et al., 2021), duplicating the assigned experiment file, renaming the copied file using participant initials for identification, and following the highlighted sections within the task.

For instance, Purple sections indicated instructions that could be removed after completion, while green sections identified areas where participants were required to perform the activities themselves. Following the "Exercise Instruction" section, usability tasks are mainly divided into three sections:

- Main Workflow
- Features and Tools
- Other Tools (*Optional*)

Each section consists of TWO tasks, and each task focuses on a primary aspect of the eLabFTW platform. Each task begins with a "Task Introduction". "Task Learning Objective" and "Task Goal", allowing participants to understand the significance of each task and, at the same time, explore, understand, and use eLabFTW features during task execution.

Section 1: Main Workflow

The first usability task Task A required participants to create a resource template and a corresponding resource in eLabFTW. In the platform, resources are used to organize laboratory items, such as equipment and samples, while resource templates define the structure and metadata fields associated with these items. The task aimed to help participants understand the relationship between a resource template and a resource, as well as how metadata fields are created and applied.

Whereas in Task B focused on creating and documenting an experiment in eLabFTW using a predefined template. As experiments represent the central space for recording laboratory activities, this task was designed to familiarize participants with organizing experimental information through metadata, categories, tags, and permissions. The task aimed to assess participants' ability to create, structure, and manage experimental records within the electronic laboratory notebook environment.

Section 2: Features and Tools

The third usability task Task C focused on adding a compound within the eLabFTW inventory system. In this context, a compound refers to a chemical substance or mixture that is stored and managed within the laboratory database. Participants were required to search for and add a relevant compound while exploring how chemical information can be integrated and linked with experimental records.

The objective of this task was to help participants understand how compounds are created, stored, and associated with experiments, as well as to assess their ability to manage chemical information within the system. While the fourth usability task Task D focused on creating and organizing the inventory system in eLabFTW. The inventory feature enables users to manage laboratory materials, equipment, chemicals, samples, and storage locations in a structured manner.

Participants were required to create an inventory structure representing laboratory items and locations while exploring how materials are organized and linked within the system. This task aimed to evaluate participants' understanding of inventory management and their ability to effectively structure, store, and connect laboratory resources within the ELN environment.

Section 3: Optional Tools

The fifth usability task Task E focused on exploring the chemical structure editor in eLabFTW. This tool enables researchers to create, visualize, and document chemical molecules directly within the platform. Although this task was optional, participants were encouraged to explore the editor by creating and modifying a simple molecule while evaluating its functionality, interface, and overall usability. The objective was to assess how effectively users could perform basic actions, understand the tool's features, and perceive its usefulness for routine research activities.

Whereas, the sixth and the final task Task F focused on exploring the open cloning tool in eLabFTW, which supports the planning and visualization of DNA cloning experiments. Participants were required to explore the tool's main features to evaluate its usability, navigation, and potential application within research workflows. The objective of this was to assess participants' ability to understand the tool's functionality and determine its practical value for experimental planning.

Usability Tasks Evaluation Criteria

Following the development of the usability tasks, evaluation criteria were established based on the extent to which participants successfully performed the required steps and achieved the expected outcomes. The evaluation was categorized into three levels: Completed, Partially Completed, and Not Completed. Based on evaluation criteria, a task is considered ‘Completed’ when all the required steps are executed correctly and the final outcome fully satisfies the task requirements.

This would indicate that participants understood the task objectives and were able to successfully apply the relevant features of the eLabFTW platform. Whereas, a task is considered ‘Partially Completed’, if a participant completes only some of the required steps and achieves a partial outcome. This would indicate an incomplete understanding of the task requirements or platform functionality.

Lastly, a task is considered ‘Not Completed’, when a participant is unable to adequately perform the required steps and no valid or usable outcome is produced. Therefore, this would indicate difficulty in applying the relevant features of the system.

4.5 Post Usability Tasks Questionnaire

Following the completion of the usability tasks, the final stage of the study involved administering a post-usability tasks questionnaire. The questionnaire was designed to assess participants’ understanding of eLabFTW, their perceptions of its usability, their willingness to adopt the platform in future research activities, and their overall level of satisfaction with the system Appendix F.

To capture comprehensive feedback, the questionnaire incorporated a combination of Likert Scale, Rating, multiple-choice and open-ended questions, enabling the collection of both quantitative and qualitative data. This mixed-question format encouraged participants to engage more thoughtfully with the questionnaire and helped reduce response bias, particularly acquiescence bias, where respondents may tend to agree with statements without careful consideration.

Consequently, this approach provides a more comprehensive evaluation of the platform from the users’ perspective. To ensure that all key aspects of the platform are systematically evaluated, the questionnaire was structured into eight sections, each focusing on a specific dimension of the user experience. Corresponding performance indicators were developed for each section to guide the evaluation and measure participants’ perceptions across different aspects of eLabFTW. These sections and their associated performance indicators are presented in Table 8.

Table 8: Post-Usability Tasks Questionnaire Sections and Performance Indicator Overview.

Section	Performance Indicator
Section A: Usability and Task Experience	System usability, task completion, learning difficulty, interface clarity.
Section B: Documentation and Research Data Management	Documentation workflow optimization and research data management support.
Section C: Searchability, Traceability, and Reproducibility	Information accessibility, metadata consistency, traceability, and reproducibility support.
Section D: Collaboration and Workflow Fit	Collaborative research support, workflow flexibility, and system adaptability.
Section E: Overall Assessment	Overall user satisfaction and system suitability.
Section F: Most useful aspects of eLabFTW	Perceived feature usefulness and system value.
Section G: Difficulties experienced while using eLabFTW	Usability issues, error sources, learning barriers, and workflow obstacles.
Section H: Open-Ended User Experience Improvement	User experience improvement, feature needs, and adoption barriers.

After developing the Post-Usability Tasks Questionnaire, an online form was created to collect participants' final responses. As the final phase of the study, emails were sent to participants containing the questionnaire link and requesting feedback on their experiences using eLabFTW. The collected responses, presented in the following chapter, provided insights into the usability and effectiveness of the platform and contributed to the final analysis and conclusions of the study. To provide a comprehensive overview of the Post-Usability Tasks Questionnaire framework, the following section presents its structure and components in detail

Post-Usability Tasks Questionnaire Framework

This section presents the structure of the Post-Usability Tasks questionnaire, including the categories and no. of questions within each section. It provides an overview of the questionnaire design and its approach to evaluating participants' experiences and perceptions of eLabFTW. The first section, "Usability and Task Experience", focuses on participants' experiences while completing the usability tasks, including ease of use, interface clarity, learning effort, and challenges encountered during interaction with eLabFTW. This section consisted of **4** Likert-Scale questions.

Whereas the second section, "Documentation and Research Data Management", evaluates participants' perceptions of eLabFTW's ability to support structured documentation and effective management of research information. This section consisted of **2** Likert-Scale Questions. Furthermore, the third section, "Searchability, Traceability, and Reproducibility" assesses how effectively eLabFTW supports access to previous records, tracking of experimental information, metadata consistency, and reproducible research practices. This section includes **3** Likert-Scale questions and **1** Rating Scale question.

The fourth section, “Collaboration and Workflow Compatibility”, examines the platform’s suitability for collaborative research environments, including permission management, information sharing, and integration with existing workflows. This section consists of **4** Likert-Scale questions and **1** Rating Scale question. Moreover, the fifth section, “Overall Assessment” provides an overall measure of participants’ satisfaction and acceptance of eLabFTW through **1** Likert-Scale question.

Whereas, the sixth section of Post-Usability Tasks Questionnaire, “Most Useful Aspects of eLabFTW”, identify the features of eLabFTW which participants perceived as most beneficial for their research activities through **1** multiple-choice question, allowing participants to select up to *five* options. The seventh section, “Difficulties Experienced While Using eLabFTW”, focuses on identifying challenges encountered during platform use and potential areas of improvement. This section consisted of **1** multiple-choice question, where participants could select up to *five* relevant difficulties.

Lastly, the final section, “Open-Ended User Experience and Improvement Feedback”, allows participants to provide additional comments and recommendations regarding their experience with eLabFTW. This section included **3** open-ended questions, including one optional question related to the ‘Chemical Structure Editor” and “Open Cloning” tools, as these features were explored through optional usability tasks.

Overall, the Post-Usability Tasks Questionnaire consisted of **21** questions, including **14** Likert-Scale Questions, **2** Multiple-Choice/Rating-Based Questions, and **3** Open-Ended questions, providing a comprehensive evaluation of participants’ experiences and perceptions of eLabFTW.

4.6 Summary

This chapter presented the methodology used to evaluate the adoption and usability of eLabFTW within the CIIMAR research environment. A two-phase approach was developed, beginning with semi-structured interviews to understand researchers’ current documentation practices, data management workflows, collaboration methods, and challenges. Although participant P/M.M-0.04 withdrew from the study after completing the interview and did not participate in the subsequent phases of this study, the interview findings, together with the previous eLabFTW training, informed the design of usability tasks that represented realistic laboratory workflows. These tasks included key platform functionalities related to resource management, experiments, metadata organization, inventory, compounds, and selected advanced features.

A post-usability tasks questionnaire was also developed to collect participants' perceptions regarding eLabFTW usability, documentation practices, benefits and challenges after completing the usability evaluation. The following chapter presents the execution of these activities and analysis of the collected results. Overall, this methodology provides a structured framework for assessing eLabFTW's effectiveness and suitability for integration into CIIMAR research workflows.

Chapter 5

Results and Findings

This chapter presents the findings from the semi-structured interviews, and usability tasks. The collected data through these evaluation methods were analyzed to provide a comprehensive understanding of participants' experiences, perceptions, and interactions with eLabFTW. It should be noted that, as previously discussed in Section 4.1, participant P/M.M-0.04 completed the semi-structured interview and only some initial steps of the usability tasks before withdrawing from the study due to work-related commitments.

Consequently, the interview findings include contributions from all four participants, while the usability tasks are based on the data obtained from the remaining participants. By integrating insights from multiple evaluation methods, this analysis identifies key patterns and themes related to usability, research practices, and user acceptance of the platform, providing a foundation for the discussion and conclusions of the study.

5.1 Evaluation of Current Data Management Practices

This section presents the results obtained from semi-structured interviews conducted with CIIMAR researchers to assess their current laboratory workflows and data management practices. Table 9 provides an overview of participants' profiles and interview details, offering context before proceeding with the thematic analysis of the interview findings.

The interview analysis indicated that all participants demonstrated an awareness of key research data management concepts, including Electronic Laboratory Notebooks (ELNs), metadata, data sharing, reproducibility, use of digital tools and contamination risks associated with paper-based laboratory practices. The findings suggest a general readiness among participants to adopt digital research tools and an understanding of the importance of structured data management practices.

Participants recognized that electronic solutions could enhance data organization, accessibility, and collaboration, while reducing contamination risks associated with the use of paper laboratory notebooks and personal electronic devices in laboratory environments. However, given the small number of participants, these findings should be interpreted as indicative insights rather than representative of the broader CIIMAR research community.

Table 9: Participants' Profile and Interview Details.

S.no.	Participant ID.	Interview Mode	Interview Time Duration	Date	Designation
a.	P/R.M-0.01	In person (CIIMAR)	22 mins & 41 secs	March 12, 2026	PhD
b.	P/J.C-0.02	In person (CIIMAR)	36 mins & 15 secs	March 20, 2026	PhD
c.	P/S.F-0.03	In person (CIIMAR)	58 mins & 39 secs	March 25, 2026	Lab Manager
d.	P/M.M-0.04	Online	45 mins & 38 secs	March 27, 2026	Principal Investigator

The interview transcripts were analyzed thematically, to explore key dimensions related to documentation practices, data management and metadata, access and control, collaboration and information sharing, as well as perceptions of ELNs. As participants' demographics were discussed earlier, the following analysis focuses on the findings associated with these dimensions.

Documentation Practices

Documentation practices emerged as a central aspect of participants´ research workflows. Although approaches varied according to individual preferences and laboratory contexts, the interviews revealed common patterns regarding the recording, organization, and retrieval of research information, as well as several challenges associated with maintaining documentation across multiple platforms and formats.

Participant P/R.M-0.01 explained that experimental observations are typically recorded on paper, during laboratory activities and later transferred to digital formats. Although this process supports laboratory safety and contamination control, it was described as time-consuming and stressful because information must subsequently be organized into multiple files and folders. Similar concerns were raised by participant P/S.F-0.03, who highlighted the practical difficulties associated with using electronic devices during experimental procedures.

In some situations temporary notes were written directly on laboratory gloves or work surfaces before being transferred into notebooks and digital records. Documentation practices varied across participants, commonly used tools included Microsoft Word, Excel, PowerPoint, Google Drive, Institutional Servers, Notion[13]and Shared Project Folders. Participant P/S.F-0.03 described a structured documentation workflow based on Word documents and standardized naming conventions, while participant P/M.M-0.04 reported using paper laboratory notebooks alongside digital organizational tools such as Notion.

[13] Notion, a productivity and workspace platform, available at Notion official website

Although participants considered their documentation practices generally effective for their own needs, a recurring issue was the fragmentation of information across multiple platforms and storage locations. Participant P/R.M-0.01 explained that experimental information was often distributed among PowerPoint presentations, Excel files, Word documents, and project folders making information retrieval difficult.

Similarly, participant P/J.C-0.02 noted that locating information from older projects frequently required searching through both physical notebooks and digital repositories, increasing the likelihood of missing important details. These challenges suggest that the dispersion of research records across multiple formats and locations hinder efficient information retrieval and continuity of work, particularly when revisiting past projects.

Overall, participants agreed that while existing documentation approaches support day-to-day research activities, they often create challenges related to information retrieval, traceability, and long-term accessibility.

Data Management Practices

Data management practices differed between participants but shared several common characteristics. Researchers relied on a diverse range of tools to support the organization, storage, and management of research data, including notebooks, spreadsheets, institutional servers, cloud storage systems, external hard drives, and specialized software platforms.

Participant P/J.C-0.02 described a metadata-intensive workflow in which environmental samples are linked to structured identifiers containing information about projects collection year and sampling contexts. These identifiers are linked to analytical workflows, metadata records, and research outputs, enabling traceability throughout the research lifecycle. Similarly, participant P/S.F-0.03 emphasized the use of standardized experimental codes applied consistently across notebooks, digital files, samples, and laboratory materials.

All participants demonstrated awareness of the importance of metadata for supporting data interpretation, traceability, and reproducibility. Commonly recorded information included sample identifiers, methodological descriptions, workflow details, environmental parameters, photographs, experimental observations, and contextual notes. Participant P/R.M-0.01 reported documenting experimental schemas, workflow descriptions, photographs, and sampling information to support future interpretation and publication activities.

Despite these examples of good practices, metadata management was not consistently formalized across participants. Metadata practices were largely informal and dependent on individual researchers or laboratory-specific conventions. Participant P/M.M-0.04 highlighted that documentation requirements often vary depending on the nature of the experiment. For example, molecular biology experiments required documentation of reaction conditions and reagent quantities, whereas bioinformatics analyses required records of software tools, parameters, and computational workflows.

Consequently, participants highlighted the importance of balancing standardization with flexibility to accommodate research contexts. The findings suggest that while researchers recognize the value of metadata and structured documentation, metadata practices remain largely driven by individual or laboratory-specific approaches, with limited evidence of formalized standards or institution-wide practices.

Research Data Access and Control

The interviews indicated that access to research information was primarily organized through project-based and institutional arrangements. Researchers described a range of practices aimed at balancing collaboration with the protection of research data. Participants reported that personal research data were usually accessible only to themselves and their supervisors, while collaborative projects relied on shared folders, institutional servers, and project-specific repositories.

Participant P/J.C-0.02 described an Institutional server environment in which individual users are assigned dedicated workspaces with restricted access permissions. This structure prevents unauthorised access by allowing collaboration among project members. Similarly participants P/S.F-0.03 explained that personal folders stored on institutional servers are only accessible to the researcher and the principal investigator, while additional shared spaces can be created when collaboration is required.

All participants considered data security an important aspect of their workflow and reported maintaining multiple backup copies of research data. Common backup strategies included external hard drives, institutional servers, and cloud storage platforms. However, several participants acknowledged limitations associated with these approaches. Participant P/S.F-0.03 expressed concerns regarding storage limitations and occasional server downtime, while participant P/M.M-0.04 noted that reliance on personal backup systems is not an ideal long-term solution.

While participants felt confident about data security, most workflows lacked formal access control mechanisms. Therefore, all of the researchers expressed interest in systems capable of supporting more advanced permission structures, particularly for collaborative projects involving multiple researchers and students.

Collaboration Work Practices and Information Sharing

Collaboration emerged as one of the most prominent themes across all interviews. Participants reported collaborating throughout multiple stages of the research process, including experimental planning, data collection, laboratory work, analysis, troubleshooting, and publication preparation. Information sharing currently relies on a combination of shared folders, institutional servers, cloud storage services, email communication, and collaborative documents.

Participant P/R.M-0.01 explained that shared project folders are frequently used for thesis projects and collaborative research activities, allowing multiple researchers to access and contribute to common datasets and documentation. Similarly, participant P/J.C-0.02 highlighted the importance of sharing analytical scripts, workflows, and methodological knowledge among laboratory members.

Despite these collaborative practices, participants identified several barriers to effective information sharing. One recurring challenge involved the discoverability of previous work. Both participants P/R.M-0.01 and P/J.C-0.02 reported situations in which locating historical information required remembering the specific project, year, or researcher associated with a particular experiment. This dependence on personal knowledge creates difficulties when researchers leave projects or the new members join research groups.

Participant P/S.F-0.03 described the existence of a shared protocol repository used by laboratory members. While this resource supports collaboration and methodological consistency, maintaining updated versions of protocols remains a challenge, as modifications are not always documented systematically.

Participants also emphasize the importance of detailed documentation for supporting reproducibility. In particular, participant P/S.F-0.03 argued that insufficient reporting of experimental conditions, regions, instruments, or procedural details often prevents successful replication of research findings. Consequently, participants generally viewed documentation as a critical component of collaborative scientific work.

On the Adoption of ELNs

All participants expressed positive attitudes toward the potential adoption of electronic laboratory notebooks and recognized its potential to address several limitations identified with current documentation practices. A common theme identified across the interviews was the need for centralization and improved accessibility of research information.

In particular, participant P/R.M-0.01 highlighted the importance of having a single platform, where documentation, datasets, images, protocols, and notes could be consolidated, reducing fragmentation and improving access to research information. Similarly, participant P/J.C-0.02 also highlighted the benefits of searchable documentation systems that would allow researchers to locate previous work more efficiently and reduce duplicated effort across research groups.

These findings indicate that participants viewed ELNs not only as tools for organizing information but also as a means of improving efficiency and reducing unnecessary workload.

Automation was another frequently discussed benefit. Participants believe that reducing manual and repetitive tasks, particularly the transfer of handwritten notes into digital systems, could significantly improve efficiency. Participant P/R.M-0.01 specifically suggested that direct uploading of notes, images, and observations into a centralized system could reduce workload while maintaining laboratory safety.

Participants P/S.F-0.03 viewed ELNs positively but expressed concerns regarding long-term sustainability and institutional commitment. Previous experience with the discontinuation of the Signals Notebook platform resulted in skepticism regarding dependence on externally managed systems. According to the participant, researchers may hesitate to invest time adopting a platform if future access to their data cannot be guaranteed.

Participant P/M.M-0.04 emphasized the importance of flexibility. While acknowledging the advantages of the structured documentation systems, the participant argued that different research domains require different documentation approaches and that ELNs should support diverse workflows rather than imposing rigid templates. Despite these concerns, all participants agreed that ELNs have considerable potential to improve documentation quality, accessibility, collaboration, traceability, and reproducibility.

Main Interview Findings

Based on the interview's empirical findings, several important insights emerged from the interviews. One of the main findings was that research documentation at CIIMAR is across multiple tools, formats, and storage locations, creating challenges for information retrieval and long-term traceability. Another important finding was that, although researchers recognize the importance of metadata and reproducibility, documentation practices remain largely dependent on individual preferences and laboratory conventions rather than formal standards.

Moreover, collaboration is a central component of research activities, however, existing systems often make it difficult to discover previous work, transfer knowledge, and onboard new researchers. Despite these challenges, a particularly encouraging finding was the positive attitude of all participants toward the adoption of ELNs. Researchers identified centralized access to information, improved searchability, automation, and enhanced collaboration as key potential benefits.

Overall, the interviews' indicate a high level of awareness regarding data management challenges and suggest strong readiness for the adoption of digital documentation solutions. These findings informed the subsequent usability evaluation of eLabFTW and provided valuable insights into the requirements and expectations of potential users within the CIIMAR research community.

5.2 Usability Tasks and Questionnaire Analysis

Based on the findings obtained from the semi-structured interviews, this section presents an integrated analysis of the results from the usability task performance and follow-up questionnaire. The combined findings provide a comprehensive evaluation of eLabFTW as a research data management system, highlighting its functional strengths and generally positive user acceptance. At the same time, the evaluation identified recurring usability challenges related to instruction adherence, the discoverability of advanced features, and consistency in task completion efficiency.

Across the usability tasks, participants demonstrated that the core functionalities of eLabFTW (e.g. resources, experiments, inventories) are usable and effective, particularly in areas such as experiment creation, resource management, metadata handling, and data organization. However, performance patterns consistently showed that while primary workflows were completed successfully, secondary and detail-sensitive steps were frequently missed or partially completed.

This included issues such as incomplete file renaming and setup actions in **(Exercise Instructions),** missing metadata fields, skipped comments and review requests, and incorrect resource linking in **(Section 1: Main Workflow),** as well as incomplete execution of inventory structures and inconsistent handling of advanced hierarchical data in **(Section 2: Features and Tools).** Optional tools **(Section 3: Optional Tools)** saw minimal engagement except by one participant "P/S.F-0.03", indicating that non-mandatory features are not naturally explored within user workflows.

A key theme across task performance is that users were able to achieve functional success in core tasks but struggled with precision, completeness, and adherence to detailed instructions. This suggests that the system supports task completion but does not always guide users toward fully correct or fully optimized workflows.

Therefore, one participant proposed, which may help address these challenges and improve user performance. However, advanced features such as ‘Inventory management’ and optional tasks related to ‘Chemical Structure Editor’ or ‘Open Cloning’ tools were particularly underutilized or inconsistently executed, indicating lower discoverability or weaker integration into primary workflows.

To provide a complete overview of the usability tasks, the next stage involved analysing and critically evaluating the findings using predefined ‘Usability Tasks Evaluation Criteria”. A total of four participants took part in the study, of whom only three successfully participated in all three stages of this study.

The analysis was conducted through the eLabFTW environment using an administrator account, which provided full visibility of system features and participant interactions. This enabled systematic monitoring, review, and verification of task performance. This approach ensured accurate and detailed assessment of usability task execution.

To support the presentation and interpretation of the usability task results, a color-coded evaluation table was developed based on usability tasks’ evaluation criteria as shown in Table 10.

Table 10: Usability Tasks Results.

Participant	Exercise Instructions *(Tasks)*	Task A	Task B	Task C	Task D	Task E (Optional)	Task F (Optional)
P/R.M-0.01	Task Completed	Partially Completed	Partially Completed	Task Completed	Task Completed	Not Completed	Not Completed
P/J.C-0.02	Partially Completed	Partially Completed	Completed but Incorrect	Task Completed	Not Completed	Not Completed	Not Completed
P/S.F-0.03	Task Completed	Partially Completed	Completed but Incorrect	Task Completed	Task Completed	Task Completed	Not Completed
P/M.M-0.04	Partially Completed	Not Completed	Not Completed	Not Completed	Not Completed	Not Completed	Not Completed

Task – A: Steps	**P/R.M- 0.01**	**P/J.C- 0.02**	**P/S.F- 0.03**	**P/M.M- 0.04**
Create a “Resource Template” (e.g. Microcosm_Flask_Template + Your Name Initial) and add custom metadata fields (i.e. Flask Barcode, Flask Type, Flask Manufacturing Date).	✗	✓	✗	✗
Using the template, create a “Resource” (e.g. Microcosm_Flask + Your Name Initial).	✓	✓	✗	✗
Attach an image (e.g. Figure-3 Visual Aspect of Microcosm Flasks).	✓	✗	✓	✗
Assign a task to the owner to review the resource (e.g. Microcosm_Flask).	✓	✗	✗	✗
To make a resource “Bookable”, locate the “Resource Booking” feature and explore the booking settings and limits available for the “Scheduler”.	✓	✗	✓	✗
Write a comment about the entire process and save.	✗	✗	✓	✗

Task-B: Steps	**P/R.M- 0.01**	**P/J.C- 0.02**	**P/S.F- 0.03**	**P/M.M- 0.04**
Create an “Experiment” using the template titled "Default Experiment Template".	✓	✓	✓	✗
Change the title of the experiment (e.g. Experiment in Natural Seawater + Your Name Initial).	✓	✓	✓	✗
Create an “Experiment Category” (e.g. Laboratory + Your Name Initial) and categorize the experiment.	✓	✓	✓	✗
Update the experiment status to "Running".	✓	✓	✓	✗
Give an “ID” to your experiment.	✗	✓	✓	✗
Define new “Tags” (e.g. Petroleum Hydrocarbons, Seawaters).	✓	✓	✓	✗
Give values to pre-defined custom fields in the experiment template.	✓	✓	✓	✗
Attach a file (e.g. Figure: 1-Hydrocarbon Degraders).	✓	✓	✗	✗
Draw a “Circle” using the “'Draw Something” feature to indicate “BushNell Haas”, in the image.	✓	✓	✗	✗
Change the “Access Permission” of the document. Thus, everyone with an account can see/view, and only the 'Owner' and 'Admin' can edit/write and save.	✓	✓	✓	✗
Link "Resource" (e.g. Microcosm_Flask - A.D) to the "Experiment" and save in the end.	✓	✗	✗	✗

Task - C	**P/R.M-0.01**	**P/J.C- 0.02**	**P/S.F- 0.03**	**P/M.M-0.04**
Search for a “Compound”.	✓	✓	✓	✗
Add the “Compound” into the laboratory system and associate it with the experiment titled “Experiment in Natural Seawater-A.D".	✓	✓	✓	✗

Task - D	**P/R.M-0.01**	**P/J.C- 0.02**	**P/S.F- 0.03**	**P/M.M- 0.04**
Explore “Inventory” within a system.	✓	✗	✓	✗
Establish an "Inventory Location" (e.g. Portugal + Your Name Initial) and structure it by assigning an appropriate "Element".	✓	✗	✓	✗
Associate the “Element” to experiments (e.g. “Experiment in Natural Seawater - A.D") storage and save.	✓	✗	✓	✗

Task - E	P/R.M -0.01	P/J.C -0.02	P/S.F-0.03	P/M.M-0.04
Explore “Chemical Structure Editor” within the system.	✗	✗	✓	✗
Using the “Chain Tool”, please draw two-carbon chain and “Single Bond” tool to select “O” (i.e. Oxygen) from the atom menu to add the “OH” group.	✗	✗	✓	✗
Simply search for “Similar Structures” and check if you obtain any results and provide feedback about this task later.	✗	✗	✓	✗
Lastly, please Interact with both the “Molecules” and “Macromolecules” modes, and assess their tools, functionality, interface, and layout and provide feedback about this task later.	✗	✗	✓	✗

Task - F	P/R.M-0.01	P/J.C-0.02	P/S.F-0.03	P/M.M-0.04
Explore 'Open Cloning' tool within the system.	✗	✗	✗	✗
Add any missing ‘Primer’ into the system and save to eLabFTW.	✗	✗	✗	✗
In the end, please interact with the remaining features of 'Open Cloning' and assess other functions, features and user interface and provide feedback about this task later.	✗	✗	✗	✗

Building on these findings, the next section discusses the post-usability task questionnaire, which further reinforces and expands the insights obtained from the usability evaluation.

Questionnaire findings show that participants’ perception of the system is broadly positive despite observed task-level inconsistencies. Participants generally agreed that eLabFTW is easy to learn and use, useful for organizing research data, and effective for supporting reproducibility processes, traceability, and collaboration among members and teams. Participants recognized the value for structuring experiments, managing metadata, and centralizing research information, confirming the strengths observed in task performance.

However, participants’ perceptions revealed mixed experiences regarding usability, clarity and efficiency. While participants did not report significant issues with the interface’s intuitiveness, neutral responses concerning clarity suggested that the system was not always immediately self-explanatory. Perceived task difficulty varied across users, with some reporting smooth experiences and others experiencing higher cognitive effort, even when task completion was achieved i.e. participant P/S.F-0.03. This aligns with task data showing that success did not always equate to ease of execution.

Regarding efficiency, participant responses were mixed. While one participant perceived the system as efficient, the remaining participants expressed neutral or negative views, suggesting that perceived efficiency may depend on user familiarity, task complexity, and prior experience with the platform. This finding aligns with the task performance results, which showed that participants generally completed the core tasks successfully but occasionally required additional effort or made minor deviations during task execution.

Despite these challenges, both the task performance data and participant feedback consistently highlighted eLabFTW's key strengths, including its ability to organize experiments and protocols, centralize research information, support traceability and reproducibility, and provide structured research workflows.

These findings suggest that the platform's perceived efficiency is likely to improve, as users become more familiar with its features and workflows. Nevertheless, although participants consistently recognized these benefits and task performance confirmed that the basic functions of eLabFTW are generally well supported and usable (e.g. Creating New Resource Entry in eLabFTW).

However, the usability task findings identify several areas requiring further improvement such as, metadata completeness and consistency, resource linking accuracy, resource booking and review request to admin to assess the completed task received relatively low levels of engagement or were completed with greater difficulty. This limited engagement of participants with optional tools may be attributed to several factors, including the time-constrained nature of the evaluation, participants' preference to prioritize mandatory tasks, or a lack of familiarity with the platform's advanced functionality.

These findings are further supported by the post-tasks questionnaire, in which participants reported difficulties with navigation, locating specific features, retrieving records, and managing certain workflows efficiently. Collectively, these results suggest that improvements to feature discoverability, navigation, and user guidance could enhance the overall usability and efficiency of the platform, particularly for less experienced users.

Furthermore, for additional insights, open-ended responses suggest that adoption and long-term usage may depend not only on usability but also on contextual and organizational factors, such as institutional integration, habitual use, and platform accessibility (e.g. tablet-friendly workflows). This indicates that usability alone is not the only determinant of sustained adoption, ecosystem and workflow embedding also play a significant role.

To support the presentation and interpretation of the findings, a consolidated table was developed. The chart integrated results obtained from both the 'Usability Tasks' and 'Post-Usability-Tasks Questionnaire', enabling a combined view of user performance and user perceptions. Table 11, highlights key patterns emerging across task execution and participant feedback.

Table 11: General Overview of "Users' Performance" and 'Users' Perceptions about eLabFTW during and Post- Usability Tasks.

Aspects	Observed Performance (Usability Tasks)	Self-Reported Perception (Questionnaire)
Ease of use / learnability	Users generally completed core workflows, but with frequent omissions and incomplete steps (metadata, naming, linking, comments).	All participants reported that eLabFTW is easy to learn and use.
Clarity of interface	Users often missed secondary actions and required steps (review requests, booking, metadata fields).	Neutral responses overall; interface perceived as neither clearly intuitive nor problematic.
Task completion (overall success)	Core tasks mostly completed, but many were partially completed or deviated from instructions.	Most participants reported they could complete tasks without significant difficulty.
Perceived effort required	High variability in actual effort: some users completed smoothly, others struggled with navigation and precision steps.	Mixed perception: some reported low effort, one reported high effort.
Metadata consistency	Frequent missing or incomplete metadata fields across participants.	Mixed perception: agreement from some users, neutral response from others.
Experiment & data organization	Generally successful creation of experiments, templates, and structured data.	Strong positive perception: users found eLabFTW useful for organizing experiments, notes, and files.
Traceability of research steps	Users successfully linked experiments, resources, compounds, and files, but occasionally incorrectly or partially.	Strong agreement: users felt traceability of experiments and files was well supported.
Resource linking accuracy	Some incorrect or missing linking of resources (e.g., wrong resource selected or not linked).	Not directly questioned, but indirectly reflected in positive traceability ratings.
Advanced feature usage (inventory, compounds, tools)	Compounds used successfully; inventory task showed difficulties and non-completion for at least one participant; optional tools mostly unused.	Positive perception of usefulness, but no strong feedback on advanced tools specifically; limited exposure implied.
Navigation & discoverability	Users struggled with locating some features (inventory, comments, review actions, optional tools).	Reported as unclear by some participants; others neutral, suggesting mixed clarity experience.
Efficiency in daily use	Workflow completion required extra steps and corrections in several cases; inconsistent execution efficiency.	Mixed responses: one negative, one neutral, one positive perception of efficiency.
Collaboration & permissions	Participants generally set permissions correctly and linked resources/experiments successfully.	Strong agreement that collaboration and access control are well supported.
Workflow fit (laboratory integration)	Users could complete structured workflows but with deviations and incomplete steps.	Participants agreed eLabFTW fits well with existing laboratory workflows.
System flexibility	Users adapted to different tasks but showed inconsistency in handling complex or advanced structures.	Mostly positive, but one neutral response indicates

		variability in perceived flexibility.
Reproducibility & traceability	Tasks completed sufficiently to support traceable workflows, though not always fully correctly executed.	Strong agreement that eLabFTW supports reproducibility and traceability.
User satisfaction	Despite usability issues, users completed most tasks successfully.	All participants reported overall satisfaction with eLabFTW.
Optional/advanced tool adoption	Very low engagement with optional tasks and tools (chemical editor, cloning).	Not directly rated, but feedback suggests low familiarity and limited exposure.

These results are further summarized alongside data collected during the supplementary study component (Online Survey) to enable a thematic and critical analysis focused on user perception and the potential long-term adoption of eLabFTW at CIIMAR or a guideline for other research institutions.

5.3 Summary

The study revealed that CIIMAR researchers currently use a combination of paper-based and digital documentation methods, resulting in fragmented information, difficulties in data retrieval, and challenges in maintaining long-term traceability. Although participants demonstrated awareness of metadata, reproducibility, and data-sharing practices, documentation approaches were largely informal and dependent on individual or laboratory-specific conventions.

Collaboration was identified as a key component of research activities, however, researchers reported challenges in locating historical information, maintaining updated protocols, and transferring knowledge between team members. Despite these limitations, all participants expressed positive attitudes toward the adoption of ELNs, highlighting benefits such as centralized documentation, improved searchability, enhanced collaboration, and greater support for reproducibility.

The usability evaluation showed that participants were generally able to complete eLabFTW's core workflows, including experiment creation, resource management, metadata recording, and data organization. However, recurring issues were observed in metadata completeness, resource linking, navigation of advanced features, and adherence to detailed instructions. Questionnaire responses further confirmed positive perceptions of eLabFTW's usefulness while identifying areas for improvement related to interface clarity, feature discoverability, and workflow efficiency.

Overall, the findings suggest that eLabFTW is a promising solution for improving research documentation, traceability, and collaboration at CIIMAR. However, these findings should be interpreted with caution due to the small number of participants involved. While the results provide valuable preliminary insights, they are not sufficient to fully represent the broader CIIMAR research community. Therefore, further assessment involving a larger and more diverse group of researchers, longer-term platform usage, and additional usability evaluation is recommended to validate these findings and better determine the long-term suitability and adoption potential of eLabFTW within CIIMAR.

The following chapter presents a discussion of the findings, together with the study limitations and recommendations.

Chapter 6

Conclusion

6.1 Discussion

The assessment of participants' current research practices revealed varying levels of digital maturity, differences in research workflows, and differing degrees of prior experience with ELNs. The findings suggest that eLabFTW has the potential to address several challenges commonly experienced by researchers across a range of scientific disciplines and research environments. Despite this variability, many of the challenges and limitations reported by participants, as well as by eLabFTW users in the Chapter 3, were remarkably consistent across the sample.

The semi-structured interview data revealed several recurring issues, including fragmented documentation practices, difficulties in information retrieval, inconsistent metadata management, challenges in collaboration, and concerns regarding the long-term preservation of research data. In contrast, responses from the online survey highlighted several perceived benefits of eLabFTW. Participants reported that the platform improves data searchability, facilitates collaboration across disciplines and projects, supports the standardized recording of research data, and provides a centralized and accessible environment for data management.

Furthermore, respondents emphasized that eLabFTW aligns with FAIR data principles, enhances traceability through comprehensive record-keeping and full-text search functionality, improves the efficiency of large collaborative research projects, and contributes to greater research reproducibility. Notably, researchers with established experience using eLabFTW generally reported more positive perceptions of the platform than participants who were new to ELNs or had limited exposure to digital research data management systems.

Although experienced users also identified certain limitations and challenges associated with the platform, their overall feedback suggests that some of the issues highlighted by participants may be mitigated through the long-term adoption and effective implementation of eLabFTW.

While these findings do not imply that eLabFTW can fully eliminate existing research data management challenges, they indicate that the platform may provide practical mechanisms to improve documentation practices, data accessibility, collaboration, and research transparency over time.

Similarly, the online survey data indicate a generally positive perception of eLabFTW among its users. Four of the ten respondents assigned the highest rating to their overall experience with the platform, while the remaining respondents provided ratings of either four or three.

Nevertheless, these results should be interpreted with caution, due to the limited number of online survey respondents (n=10) and interview participants (n=4). Furthermore, participants in both the survey and interviews reported several challenges and limitations associated with the platform such as unclear navigation, confusing interface, managing files.

Consequently, while the findings provide preliminary evidence of the potential benefits of eLabFTW, they do not support broad generalisations regarding its effectiveness across different research contexts. Additional research involving larger and more diverse participant samples would be necessary to further validate these findings.

Although the overall perception of eLabFTW among online survey respondents was generally positive, participants also reported several challenges associated with its adoption and long-term use. These included concerns regarding the platform's usability, such as a non-intuitive and time-consuming interface, difficulties in establishing structured and machine-readable FAIR data workflows, and limitations in enforcing standardized data entry templates.

Respondents also highlighted organizational and technical barriers, including compliance with local institutional policies, the provision of secure and accessible infrastructure, scalability challenges, and the need to ensure reliable access across different research environments. Furthermore, some participants identified user adoption and the transition from paper-based to digital record-keeping practices as significant obstacles.

These findings suggest that, while eLabFTW may offer substantial benefits for research data management, its successful implementation depends on a combination of technical, organizational, and user-related factors that warrant further investigation.

The semi-structured interviews provided valuable insights into the participants' current research data management practices and highlighted several areas in which eLabFTW could potentially address existing challenges. However, the results of the usability task evaluation indicate that, as first-time users of eLabFTW, none of the participants were able to successfully complete all the required steps for every task.

Despite encountering difficulties during usability tasks and not successfully completing all task requirements, participants generally perceived eLabFTW as relatively easy to use. Although some aspects of the platform were considered unclear and required additional effort to navigate, participants recognized several potential benefits associated with its adoption. These included support for organizing experimental records, protocols, and good research data management, as well as facilitating access to previous records, traceability of experimental procedures, metadata documentation, reproducibility, access control, and collaboration among research team members.

Participants also indicated that eLabFTW could integrate reasonably well with their existing research and laboratory workflows. Furthermore, they perceived the platform somehow sufficiently flexible to accommodate different experiment types and research activities. However, participants did not consider eLabFTW to be fully efficient for daily use at this stage, likely reflecting their limited experience with the platform and the challenges encountered during the usability tasks. Nevertheless, there is overall satisfaction with the platform.

Several usability strengths were identified, including the organization of experiments, information accessibility, traceability, search functionality, flexibility, and support for collaboration. At the same time, one of the participant reported difficulties related to file management, uploading or organizing files, and locating certain features within the platform. Participants suggested several improvements, such as increasing storage capacity for attachments, annexes and enhancing the integration of figures and images within experiment records.

Although the findings should be interpreted cautiously, participants expressed a willingness to continue using eLabFTW if provided with additional training and time to become familiar with its functionality. This observation is consistent with feedback obtained from the online survey, where experienced users reported more favorable perceptions of the platform after prolonged use. Consequently, participants indicated that eLabFTW could be considered a viable option for implementation as a centralized research data management tool within their research teams and expressed interest in adopting and incorporating it into their regular workflows.

Interview findings also revealed concerns regarding the long-term sustainability and adoption of eLabFTW. All the participants questioned whether the platform would continue to be supported after the pilot phase and were reluctant to invest time in a system whose future availability remained uncertain. These concerns were reinforced by previous experiences with discontinued research platforms, which raised issues related to data accessibility, institutional commitment, and the risks of storing critical research information in externally managed systems.

Participants also noted that, although eLabFTW offers extensive customization options, developing and implementing discipline-specific templates and workflows may require technical expertise beyond that of many researchers, particularly those with limited computational experience. As a result, the platform’s flexibility may itself become a barrier to broader adoption.

6.2 Limitations

In addition to the semi-structured interviews and usability evaluation conducted at CIIMAR, an online survey was distributed to researchers from international research institutes to explore broader perspectives on the adoption and usability of eLabFTW. However, the survey yielded a relatively low response rate, limiting the diversity of perspectives captured and reducing the generalizability of the findings.

One possible explanation is researchers' concerns regarding data ownership, long-term accessibility of records, and compliance with data protection regulations may have influenced participants in the survey or participants might also find survey fatigue that may have contributed to the limited engagement. Whereas participants from CIIMAR, due to workload and work commitments, found it difficult to engage consistently with the research process. This resulted in the need for frequent reminders for participants to complete certain tasks and led to the withdrawal of P/M.M-0.04 before the usability evaluation.

A further challenge concerns the design of usability tasks for the eLabFTW pilot implementation at CIIMAR. As the platform is still in its early adoption phase, few researchers have migrated their experimental records or established workflows within the system. Consequently, realistic usability tasks cannot be based on existing institutional data and require the manual creation of representative experiments and scenarios. This may reduce the ecological validity of the evaluation, as participants will interact with simulated rather than fully integrated research workflows.

Finally, the usability evaluation was conducted over a two to three week period during which participants completed tasks independently within their normal work environment. While this approach reflected real-world usage conditions, it prevented direct observation of user interactions, navigation patterns, errors, and problem-solving strategies. Consequently, the study relied primarily on self-reported feedback and task outcomes, limiting the ability to capture detailed behavioral insights into system usability.

These limitations were considered when interpreting the final results and findings, as they may influence both the assessment of usability and the broader evaluation of eLabFTW adoption within academic research environments. Overall, the findings indicate that eLabFTW is a useful platform for managing research data, but further evaluation is needed to better understand its usability in different research settings.

Future studies should include a larger and more diverse group of participants and allow more time to explore both fundamental and advanced features. Long-term evaluations would also help determine whether usability and efficiency improve as users become more familiar with the platform. In addition, user feedback should be used to improve navigation, feature discoverability, and workflow efficiency, leading to a more effective and user-friendly system.

6.3 Recommendations

During this work, participants highlighted several aspects and needs related to improving their day-to-day research work, which eLabFTW can address. Participants agreed that eLabFTW is easy to use, easy to learn and effective for organizing experiments, notes, and protocols.

Similarly, participants agreed that eLabFTW supports good research data management practices and enhances the traceability of research activities, permission settings, collaboration features, and the platform's flexibility in accommodating different experiment types and research activities makes eLabFTW suitable for CIIMAR.

However, participants, identified several factors that would facilitate the adoption of eLabFTW in their research work that are more closely related to the institutional level.

These included institutional and research group support, such as the formal integration of the platform into daily workflows and training students to use it. Participants also indicated that adoption would be easier if the system were more user-friendly, particularly if it offered improved functionality on tablets and provided an experience closer to that of a traditional handwritten laboratory notebook.

However, institutional support, encouragement, and adoption policies are also major factors that can help researchers adopt the tool despite some challenges and difficulties. In addition, participants felt that regular use of the platform would increase familiarity and, over time, improve ease of use. Overall, the results suggest that both organizational support and usability, together with consistent exposure, are key factors in encouraging the continued adoption of eLabFTW at CIIMAR to improve research and documentation practices.

Appendix

This appendix presents the supplementary materials used in this study, including details on the use of AI, the design of the online preliminary eLabFTW assessment survey, semi-structured interview guide, usability testing tasks, consent form, and post-usability questionnaire. A shared link containing all study-related materials and resources is also provided to support transparency and facilitate access to the complete research documentation.[14]

➢ Appendix A: Use of Artificial Intelligence (AI) in Dissertation Report

ChatGPT	Used to check grammatical mistakes and errors, brainstorming, conceptualization, improve text and sentences, topics and theme alignment, search publications, enhance ideas and report layout, ideas about surveys, interviews, usability tasks, and questionnaires.
DeepL	Used to translate non-English language research papers, MCI documents from Portuguese or French to English language.
SciSpace	Used to extract useful information from selected research papers to avoid mistakes during data collection and literature review process.
Microsoft Word Voice Typing	Used to instantly convert ideas, results and outcomes during participants' interview and usability tasks analysis, ensuring no important details are missed during interviews and usability evaluation.

➢ Appendix B: Online Survey: eLabFTW in International Research Institutes

GDPR Privacy Note

1. This Survey collects information solely for my academic dissertation research on eLabFTW. Participation is voluntary, and by submitting the form you provide your consent (GDPR Art. 6(1)(a)).

2. Only the information you choose to provide will be collected. No personal or identifying data is required. Responses are stored securely via Google Forms, which operates under GDPR-compliant data-processing terms.

[14] https://drive.google.com/file/d/1qeex-OTqRk4zTBpkG7-8K-qFwtP9d3fm/view?usp=drive_link

3. Data will be accessed only by me, used exclusively for this research, and will not be shared with any third parties. All the responses will be deleted once the dissertation is completed.

4. You may request correction or deletion of your response at any time.

Likert Scale

1: Not Satisfied 2: Satisfied 3: Neutral 4: Satisfied 5: Most Satisfied

Questions:

1. What is the name of your institution?
2. Where is your institution located?
3. How long has your institution been using eLabFTW?
4. What is your research field and the type of data utilized?
5. How would you rate overall experience with eLabFTW?
6. Please describe the most significant challenge encountered during eLabFTW implementation (in one sentence)?
7. Please describe the greatest benefit gained from using eLabFTW(in one sentence)?

➢ Appendix C: Consent Form

Informed, free and illustrated consent for participation in research in accordance with the declaration of Helsinki[15] and the Oviedo[16] Convention

Please read the following information carefully. If you find anything incorrect or unclear, do not hesitate to request further information. If you agree with the proposal made to you, please sign this document.

Title of the Study: eLabFTW as a Tool for Managing and Documenting Scientific Data: A Case Study of Its Adoption at CIIMAR.

Study Explanation: This study will involve semi-structured interviews, usability task and post-usability task questionnaire with research groups across various scientific areas, aiming to identify good practices in scientific documentation and data management at CIIMAR, understand the requirements and challenges of the data lifecycle in different laboratory contexts, assess the suitability and usefulness of eLabFTW for researchers, and provide recommendations

[15] http://epidemiologia.med.up.pt/pdfs/Helsinq.2013.pdf
[16] http://dre.pt/pdf1sdip/2001/01/002A00/00140036.pdf

for the effective adoption of an electronic lab notebook (ELN) tailored to diverse data types, workflows, and sharing needs.

Participation in the study involves conducting a semi-structured interview, usability tasks and Post-Usability Task Questionnaire. During semi-structured interviews, participants' responses will be audio-recorded via cell-phone for later transcription and analysis. Participants will be identified, as the study aims to contextualize the responses within their research areas.

Recordings will be deleted after completing dissertation research. Transcriptions and results will be used in the dissertation and in potential scientific publications, being preserved in a way that respects the ethical principles of research.

Terms and Financing: The study is not funded by any institution. Participation in this study is entirely voluntary and does not involve any financial compensation or material benefit. Therefore, there are no costs or losses associated with your participation. Your decision to participate or not participate in the study will not have a negative impact on your relationship with the researchers or any entity involved.

Confidentiality and Identification: This study guarantees the confidentiality and exclusive use of the data collected for academic purposes. In line with the principles of transparency, participants will [not] be identified by name, position, and area of study, information that will be used solely and exclusively for the analysis and dissemination of the results within the scope of this study. The interviews will be recorded for the purposes of recording and analysis, ensuring that their content will be treated confidentially and used only in an academic context. Participants hereby declare their consent to the recording of interviews and to the use of data as described above.

I, HASSAN MUSTAFA SHOAIB, a Master's student in Information Science at the University of Porto, with the email address [email address], would like to thank [name of the participant] for their availability and willingness to participate in this study.

Signature: ____________________________________

I declare that I have read and understood this document, as well as the information provided to me by the person signing above. I have been assured that I may refuse to participate in this study at any time without any consequences. I therefore agree to participate in this study and consent to the use of the data I voluntarily provide, trusting that it will only be used for this research and relying on the guarantees of confidentiality and anonymity given to me by the researcher.

Name: … … … … … … … … … … … … .. … … … … … … … … … … … … … …

Signature: … … … … … … … … … … … … .. … … … … … … … … … … … … …

Date: …… /…… /………..

THIS DOCUMENT CONSISTS OF 1 PAGE AND IS MADE IN DUPLICATE: ONE COPY FOR THE INVESTIGATOR, THE OTHER FOR THE PERSON GIVING CONSENT.

- **Appendix D: Semi-Structured Interview Script**

Researcher:

Date:

Note: This interview is conducted as part of my master's thesis and will contribute to research carried out at CIIMAR. The primary objective of this interview is to examine current research data management practices adopted by researchers working in laboratory environments at CIIMAR and to assess, whether researchers require a new tool or system (i.e. Electronic Laboratory Notebook) respectively.

Demography:

Q1. Could you briefly describe your current role and the type of research you are conducting?

Follow-up (if needed):

- What does a typical experiment or study look like?
- What kind of data are involved?

Documentation Practices:

Q1. How do you currently document your experiments or research activities?

Follow-up (if needed):

- Do you annotate on a physical notebook, or a digital tool or both?
- When do you usually take notes - during or after experiments?

Q2. How would you describe your current documentation practice?

Follow-up (if needed):

- What works well?
- What could be improved?
- Do you use any formal practice?
- Is it personal or agreed with your team?

Q3. What kind of information do you record to help others understand your data or experiments?

Follow-up (If needed):

- Nil.

Q4. Do you experience any difficulties when manually documenting experiments?

Follow-up (If needed):

- Time?
- Missing details?
- Inconsistency?
- Reproducing past work?

Access and Control:

Q1. Who has access to your research data?

Follow-up (If needed):

- Nil.

Q2. Do you feel your data is secure in your current system?

Follow-up (If needed):

- Nil.

Q3. Are there different levels of access to the data (e.g., read-only, editing, and administration)? How are these managed? Ex. To explore permission structure, not just who can access.

Q4. Who controls it?

Follow-up (If needed):

- Nil.

Q5. What measures are in place to prevent data loss or unauthorized access?

Follow-up (If needed):

- Nil.

Data Management Practices:

Q1. What do you use to organize your "Lab Work"? and How? Ex. Paper Labs Notebooks (PLNs), Microsoft Word/Excel, Shared Drive(s), Laboratory Information Management System (LIMS).

Q2. Do you take notes during experiments? Ex. Papers or Computers. Detailed or Short-Notes.

Q3. Tell me about your perspective on your current documentation practices and system?

Follow-up (If needed):

- Overall do you think that your practices are suitable, do you have any positive/negative experiences based on your practices?

Q4. How often do you revisit old experiments, and how easy is it to understand the documentation later?

Q5. Are you familiar with the concept of "Metadata"? How would you define metadata? Ex. Do you use any standards?

Q6. What information do you often record about your data? The contextual information that you think is essential to understand the context of your data? Ex. Schematic Description, Textual Information, Experimental Entries, Workflow Description, Tags.

Q7. How do you ensure that your documentation remains consistent and complete over time?

Collaborative work:

Q1. Are your practices the same as your colleagues?

Follow-up (If needed):

- Your goal is to understand if there are any kind of positive aspects or barriers for sharing information within the research teams

Q2. At what stages of the research process do you typically collaborate with others? Ex. (e.g., planning, experimentation, analysis)?

Q3. How do you share your research work? If needed. Ex. USB Drives, Email, Shared Driver(s), External Hardware, Laboratory Management Software.

Q4. What information do you think is most critical to record so that someone else can repeat your experiment?

Follow-up (If needed):

- Nil.

Q5. How do you collaborate with others in your research?

Follow-up (if needed):

- How is information shared within your team?

Q6. Are documentation practices similar across your team?

Follow-up (if needed):

- Do differences create challenges?

Q7. Do you think your current practices make it easy to reproduce experiments? Why or why not?

Future Improvements:

Q1. If you could improve one aspect of how you document or manage experiments, what would it be?

Q2. Have you ever considered changing the way you document your research? What would motivate that change? *(Optional, only if natural)*

Q3. Have you heard of electronic lab notebooks? What is your perception of them?

- **Appendix E: Usability Tasks**

Introductory Note:

In this usability study, you will use eLabFTW to manage a "Microcosm Bioremediation Experiment in Natural Seawater",[17] using a published article as a reference while practicing experimental documentation. You will set up and configure an experiment, organize associated resources, manage inventory, and utilize tools such as the Chemical Structure Editor and the Open Cloning Tool. Please follow the instructions provided and feel free to explore the platform's features. Disclaimer: The primary objective of this hands-on activity (usability task test) is to evaluate and familiarize yourself with eLabFTW's capabilities for experiment documentation and resource integration; strict scientific accuracy is not the focus.

Exercise Instructions:

- The reference paper used in this study is available at the provided link. Click Here
- It is recommended that the paper remain open in a separate tab throughout the completion of this exercise for ease of reference.
- During the "Usability Task", please keep this experiment 'Open' in one tab and navigate eLabFTW in another tab.
- Before starting the "Usability Task," duplicate the "Experiment File," rename the copy to include your initials (e.g., Usability Tasks Test Sheet_A.D), and continue the exercise using this renamed copy.

[17] Perdigão et al., "Bioremediation of Petroleum Hydrocarbons in Seawater," 2285.

- You may name the file as you prefer, but please include in the name your initials (e.g. filename_A.D)
- The instructions for the tasks are indicated in 'Purple' and may be removed once the corresponding activities have been completed.

Section-1: Main Workflow

Task A: Create a resource template and a resource.

I. Intro: In eLabFTW, “Resources” are used to manage and organize lab equipment, samples, and reusable items in a structured way. Whereas, “Resource Template” defines the structure and metadata, while “Resources” are the actual instances used in the experiment.

II. Learning Objective: Create and configure a “Resource Template” (e.g. Microcosm_Flask_Template) and a corresponding “Resource” (e.g. Microcosm_Flask) to represent lab equipment, and explore how metadata and template structures are defined.

III. Goal: Assess whether users understand the difference between “Resource Template” and “Resource”, and how they interact with metadata fields when creating and configuring them.

a) Please follow and check the steps from (A-1 to A-6) of this experiment to complete the task.
b) When you finish all the tasks, link the resource here: XXXXX

A-1: Create a “Resource Template” (e.g. Microcosm_Flask_Template + Your Name Initials) and add custom metadata fields (i.e. Flask Barcode, Flask Type, Flask Manufacturing Date).

A-2: Using the template, create a “Resource” (e.g. Microcosm_Flask + Your Name Initials).

A-3: Attach an image (e.g. Figure-3 Visual Aspect of Microcosm Flasks).

A-4: Assign a task to the owner to review the resource (e.g. Microcosm_Flask).

A-5: To make a resource “Bookable”, locate the “Resource Booking” feature and explore the booking settings and limits available for the “Scheduler”.

A-6: Write a comment about the entire process and save.

Task B: Create an experiment.

I. Intro: In eLabFTW, an experiment is the core place where researchers document everything they do in the lab.

II. Learning Objective: Create and document an “Experiment” using a template (e.g. Experiment in Natural Seawater), and explore how experimental information, metadata, and permissions are organized within the system.

III. Goal: Assess whether users can create and structure an “Experiment”, and understand how to organize information using “Categories”, “Tags”, “Metadata”, and “Permissions”.

a) Please follow and check the steps from (B-1 to B-11) of this experiment to complete the task.
b) When you finish all the tasks, link the experiment here: XXXXX

B-1: Create an “Experiment” using the template titled "Default Experiment Template".

B-2: Change the title of the experiment (e.g. Experiment in Natural Seawater + Your Name Initials).

B-3: Create an “Experiment Category” (e.g. Laboratory + Your Name Initials) and categorize the experiment.

B-4: Update the experiment status to "Running".

B-5: Give an “ID” to your experiment.

B-6: Define new “Tags” (e.g. Petroleum Hydrocarbons, Seawater).

B-7: Give values to pre-defined custom fields in the experiment template.

B-8: Attach a file (e.g. Figure: 1-Hydrocarbon Degraders).

B-9: Draw a “Circle” using the “'Draw Something” feature to indicate “BushNell Haas”, in the image.

B-10: Change the “Access Permission” of the document. Thus, everyone with an account can see/view, and only the 'Owner' and 'Admin' can edit/write and save. B-11 Link "Resource" (e.g. Microcosm_Flask) to the "Experiment" and save in the end.

Section-2: Features and Tools

Task C: Adding a compound

I. Intro: In eLabFTW, “Compound” is typically used as part of the Inventory system to represent a specific chemical substance or mixture stored in the lab. In order to achieve it, complete the following tasks:

II. Learning Objective: Search for and add a relevant compound, and explore how chemical information can be integrated and associated with an experiment.

III. Goal: Assess whether users can find and integrate chemical information, and understand how compounds are associated with experiments.

a) Please follow and check the steps from (C-1 to C-2) of this experiment to complete the task.

C-1: Search for a “Compound”.

C-2: Add the “Compound” into the laboratory system and associate it with the experiment titled “Experiment in Natural Seawater”.

Task D: Create and organize the inventory

I. Intro: In eLabFTW, the “Inventory” feature is used for managing and tracking laboratory materials, equipment, chemicals, samples, and storage locations in a structured manner.

II. Learning Objective: Create and organize an “Inventory” structure representing laboratory locations and materials, and explore how items are structured and linked within the system.

III. Goal: Assess whether users understand how “Inventory” structures work, and how to organize and link materials within the system.

a) Please follow and check the steps from (D-1 to D-3) of this experiment to complete the task.

D-1: Explore “Inventory” within a system.

D-2: Establish an "Inventory Location" (e.g. Portugal + Your Name Initials) and structure it by assigning an appropriate “Element".

D-3: Associate the “Element” to the experiment’s (e.g. “Experiment in Natural Seawater - A.D") storage and save.

Section-3: Optional Tools

Task E: Chemical Structure Editor

I. Intro: The “Chemical Structure Editor” in eLabFTW is used to help researchers draw, visualize, and document chemical molecules directly within the system.

II. Learning Objective: Explore the “Chemical Structure Editor” by creating and modifying a simple molecule, and assess its functionality, interface, and usability.

III. Goal: Assess usability of the “Chemical Structure Editor”, including ease of interaction, clarity of interface, and ability to perform basic actions.

a) Please follow and check the steps from (E-1 to E-4) of this experiment to complete the task.

b) After completing the task, please share your feedback on “Chemical Structure Editor” usability, clarity, and ease of interaction and to what extent would you consider using this tool in your day-to-day tasks?

E-1: Explore “Chemical Structure Editor” within the system.

E-2: Using the “Chain Tool”, please draw two-carbon chain and “Single Bond” tool to select “O” (i.e. Oxygen) from the atom menu to add the “OH” group.

E-3: Simply search for “Similar Structures” and check if you obtain any results and provide feedback about this task later.

E-4: Lastly, please Interact with both the “Molecules” and “Macromolecules” modes, and assess their tools, functionality, interface, and layout and provide feedback about this task later.

Task F: Open Cloning Tool

I. Intro: The “Open Cloning” Tool in eLabFTW is used for planning and designing DNA cloning experiments in a structured, visual way.

II. Learning Objective: Explore the “Open Cloning” tool and its main features, and assess its usability, clarity, and potential use in your workflow.

III. Goal: Assess usability of the “Open Cloning” Tool, including navigation, understanding of features, and perceived usefulness.

a) Please follow and check the steps from (F-1 to F-3) of this experiment to complete the task.

b) After completing the task, please share your feedback on 'Chemical Structure Editor' usability, clarity, and ease of interaction and to what extent would you consider using this tool in your day-to-day tasks?

F-1: Explore 'Open Cloning' tool within the system.

F-2: Add any missing ‘Primer’ into the system and save to eLabFTW. For example:

- T7 Promoter Primer - Sequence 'TAATACGACTCACTATAGGG’
- T7 Terminator Primer - Sequence ‘GCTAGTTATTGCTCAGCGG'

- SP6 Promoter Primer - Sequence: 'ATTTAGGTGACACTATAG'
- T3 Promoter Primer - Sequence 'AATTAACCCTCACTAAAGGG'
- CMV Forward Primer - Sequence: '-CGCAAATGGGCGGTAGGCGTG'.

F-3: In the end, please interact with the remaining features of 'Open Cloning' and assess other functions, features, and user interface and provide feedback about this task later.

- **Appendix F: Post-Usability Tasks Questionnaire**

Description

This questionnaire evaluates your experience using eLabFTW after completing the assigned tasks. It covers usability, documentation, search, collaboration, workflow fit, and overall satisfaction. Your responses will be used only for research purposes to evaluate the usability and effectiveness of eLabFTW.

Response Scale: For each statement, please select the option that best reflects your experience.

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

Estimated Completion Time: Approximately five minutes.

Mixed Questions (Likert Scale, Checkbox and Rating Scale)

Question 1: eLabFTW was easy to learn and use.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 2: The interface was not always clear or intuitive.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 3: I was able to complete the assigned tasks without significant difficulties.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 4: As a new user, eLabFTW requires more effort than expected.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 5: eLabFTW is useful for organizing experiments, notes, protocols, and files.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 6: eLabFTW supports good research data management practices.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 7: Rate eLabFTW for finding previous experimental records.

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Question 8: eLabFTW makes it easier to trace experimental steps, associated files, and related resources.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 9: eLabFTW helps record metadata more consistently.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 10: eLabFTW supports reproducibility and traceability of research activities.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 11: Permission settings support appropriate visibility, editing, and access control.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 12: Rate eLabFTW for supporting collaboration between researchers.

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Question 13: eLabFTW fits well with my existing laboratory workflow.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 14: eLabFTW is flexible enough for different experiment types and research activities.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 15: The system is not efficient to use in daily work.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 16: Overall, I am satisfied with eLabFTW.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Question 17: Which aspects of eLabFTW were most useful for your research work?

Select up to 5 options:

☐ Ease of use
☐ Clear and intuitive interface
☐ Organization of experiments, notes, protocols, and files
☐ Centralized access to information
☐ Searchability of previous records
☐ Traceability of experimental steps, files, and resources
☐ Metadata recording
☐ Templates or structured fields
☐ Support for reproducibility
☐ Collaboration and permission management
☐ Fit with existing laboratory workflow
☐ Flexibility for different research activities
☐ Other:

Question 18: Which difficulties did you experience while using eLabFTW?

Select up to 5 options (Note: If you did not experience difficulties, select only the first option).

☐ I did not experience significant difficulties
☐ Navigation was unclear
☐ Some features were difficult to find
☐ The interface was confusing
☐ Creating or editing entries was difficult
☐ Uploading or managing files was difficult
☐ Searching for previous records was difficult
☐ Tracing experimental steps, files, or related resources was difficult
☐ Permission or sharing settings were difficult to understand
☐ Templates or structured fields were difficult to use
☐ The system did not fit my usual workflow
☐ Other

<u>Questions: Open-Ended</u>

Question 19: What specific features, usability improvements, or changes would improve your experience using eLabFTW?

Question 20: If you used the 'Chemical Structure Editor' or 'Open Cloning' tools in eLabFTW, please briefly describe your experience and provide any feedback (optional).

Question 21: What would make you more likely to adopt eLabFTW as part of your regular research workflow?

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