Project Plan
LegaSea 2.0
Investigating real-time AI feedback to improve image quality of fossil submissions

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Chapter 1

Background and Context

Paleontology in the Netherlands has changed in recent years through the rise of citizen science. Thousands of fossils and artifacts have been found by beach-goers and amateur fossil hunters, most commonly on beaches, in fishing nets, and from dredged sand. These findings give insight into the late-Quaternary ecosystems. Projects like **LegaSea**, coordinated by Naturalis Biodiversity Center and academic partners, aim to reconstruct the natural environment and animal history of the ice age. The submissions of citizen scientists are vital in enlarging the available dataset, but their scientific value is highly dependent on the quality of the documentation of the submissions. To address this, platforms such as oervondstchecker.nl let participants upload images of their fossils. They get validated by experts and are used to train AI models to make predictions on the species. A prototype is available at museum.identify.biodiversityanalysis.nl. In the past, user needs were studied through questionnaires and requirement-gathering. A survey by Isaak Eijkelboom in PaleoTime-NL confirmed that users highly value accurate identifications (avg. score 9.3/10) and quick access to reference collections (7.7/10), but they report current limitations such as the absence of search tools, educational features, or real-time image guidance.

Chapter 2

Problem Description

Currently, the LegaSea system is a static, web-based workflow. Users can upload a picture through forms, and volunteer experts classify them. While this has resulted in 75,000 validated submissions, the metadata collection is limited, and the data quality is inconsistent. The feedback loop between user and expert is slow and discouraging. Submissions can contain blurry, poorly lit, or incomplete fossils, which diminishes their scientific utility and AI training effectiveness. Furthermore, the current web application does not support guiding users in capturing high-quality images — issues such as pixel quality, angle, and lighting remain unaddressed, regardless of whether the photos are taken on-site or at home. There is no feedback given to users about the quality of their submissions. Although citizen science platforms like iNaturalist provide community guidelines to assist users in taking higher-quality images for their submissions (Mickley, 2024), these guidelines are not integrated into the image-taking process. This creates a research gap, as there is currently no system designed to support fossil hunters with fast, actionable guidance to improve the quality of their images before uploading. To address this issue, this project focuses on improving the user experience with a more user-friendly data collection process, one that streamlines the workflow and provides users with real-time feedback about their image quality before the submission is sent. This feedback can consist of features such as on-screen guidance for capturing high-quality images and suggesting improvements to angle, lighting, and focus before submission.

Chapter 3

Research

This project is executed as part of the Master of Applied IT study. Thus, the focus lies not on the product itself, but on the research aimed at answering a specific research question. This chapter outlines the research focus, explaining what is being studied, the reasons behind it, and the methodologies employed.

3.1 Research Gap

While citizen science platforms like iNaturalist and Oervondstchecker.nl have made progress in engaging the public in fossil documentation, there remains a gap in real-time, AI-driven feedback to improve image quality at the point of capture. Current platforms rely on post-submission expert validation, which is slow and does not guide users in capturing high-quality images. Existing research (e.g., (Mickley, 2024)) highlights the importance of image quality for scientific utility, but no system currently integrates immediate AI feedback to address issues like lighting, angle, and focus during the image capture process. This project aims to fill this gap by developing and testing a prototype that provides immediate, actionable feedback to users, thereby improving the scientific value of citizen-submitted fossil images.

3.2 Research Questions

This research project investigates how artificial intelligence (AI) can be used to improve image quality prior to image capture. The various questions involved in the project are categorized into two main groups: **preparatory questions** and **research questions**. Preparatory questions focus on clarifying definitions, standards, and current challenges, drawing on existing literature, the LegaSea project's work, and expert opinions. In contrast, research questions are addressed through data collection and experimentation. The primary research question to be answered in this project is **how fossil images captured with AI-assisted real-time feedback compare to those captured without such guidance in terms of image quality**.
Before the main research question can be answered, several preparatory questions must be addressed. This process does not require the gathering of new data. It serves to define the necessary standards and context for interpreting eventual experimental results. One key preparatory question examines the characteristics that research-grade images must possess to evaluate the performance of the AI feedback system. Another group of preparatory questions investigates how fossil submissions are currently made by citizen scientists on platforms like Oervondstchecker. The

quality of these submissions and the challenges encountered in the submission process need to be assessed. Answers to these questions will reveal weaknesses in the current process that a new system could target and improve.
Only after resolving the preparatory questions can the sub-questions be investigated through the collection of new data. The first sub-question asks how real-time feedback can be provided to users during the image capture process through AI. Feedback can be communicated via various methods, such as text prompts, icons, augmented-reality overlays, or tactile signals like vibrations. Another important question involves how these methods can assist users in capturing better images intuitively and engagingly. Once these methods are developed into a prototype, testing of their impact will be conducted. The evaluation will compare submissions from citizen scientists using AI feedback to those submitted without it. Criteria for this assessment will include evaluations from expert paleontologists, the accuracy of AI model predictions, and indicators of user engagement. A summary of the main research question and sub-questions is provided in Table **??**.

3.3 Applied Methods

To define and measure the quality of fossil images in the context of paleontology and citizen science, this project builds on the qualitative assessment conducted by Naturalis researcher Isaak Eijkelboom. Eijkelboom's study established expert-driven criteria for image quality, based on ratings from ten paleontology experts. To complement this qualitative approach, quantitative automated metrics—such as BRISQUE and NIQE—will be integrated. By combining these expert-defined criteria with objective image quality scores, a hybrid evaluation framework will be created. This framework will serve two purposes: first, to assess the quality of citizen-submitted fossil images, and second, to evaluate the effectiveness of the AI feedback system in improving image quality during the prototype testing phase. Figure 3.1 visualizes the process of defining image quality.

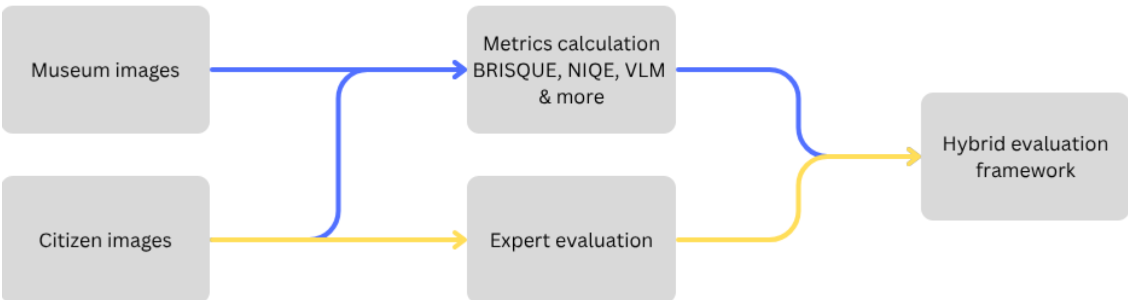

Figure 3.1: Workflow for developing a comprehensive definition and scale for image quality

Following the creation of the framework, a user study will be conducted to assess how citizen scientists currently capture fossil images and to identify opportunities for AI-assisted feedback. Participants will be asked to photograph a set of objects, ideally fossils. During this process, their actions, challenges, and preferences will be observed, either through direct observation or via a survey. The survey will focus on understanding their experience with image capture, including challenges they face (e.g., lighting, focus, angles) and their openness to different types of real-time feedback mechanisms. Participants will be asked to evaluate potential feedback methods, such as on-screen text prompts, visual overlays, or augmented reality cues, to determine which approaches are most engaging and helpful. This data will inform the design of the AI feedback system, making sure it meets user needs and preferences. Based on the knowledge gathered from the hybrid quality framework and the user study, two to three prototype versions of the AI feedback system will be developed. These prototypes will consider design principles from UI/UX best practices, relevant literature, and the specific needs identified in the survey. Each prototype will explore different feedback mechanisms—such as text prompts, visual overlays, or augmented reality cues—to determine which approach most effectively guides users in capturing high-quality fossil images. To evaluate the prototypes, an A/B testing methodology will be used. Participants from the target audience—citizen scientists—will be divided into groups, each testing a different prototype version. Their performance, measured by the hybrid quality framework, will be compared against a control group using the existing submission process without AI feedback. User feedback on usability and engagement will also be collected through surveys. The results will identify the most effective prototype. The workflow of the methodologies is visualized in Figure 3.2, presented in a sequential order.

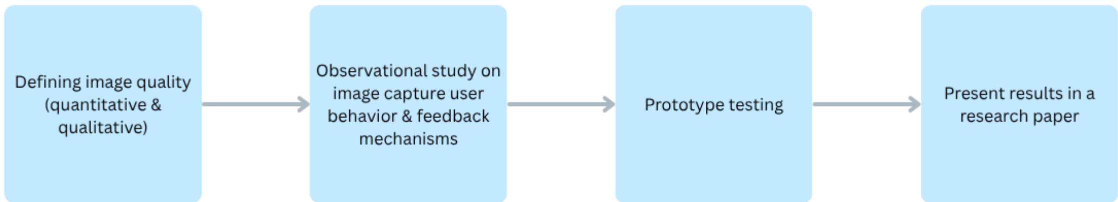

Figure 3.2: Research Methodologies workflow

Chapter 4

Scope

The scope of this research project defines its boundaries, objectives, and deliverables. This chapter clarifies what the project aims to achieve, outlines any constraints, and specifies aspects that will be excluded. By establishing a clear scope, the project ensures it meets stakeholder expectations and remains feasible. The appendix includes a work breakdown structure (Figure 8.1) that visualizes the activities done during this project.

This project includes the following activities: Research and Analysis will be conducted to understand current practices in citizen science and fossil imaging. This includes a literature review of platforms like iNaturalist and Oervondstchecker.nl, analysis of existing survey data (e.g., PaleoTime-NL), and expert interviews with paleontologists. The development of a hybrid quality framework is a major aspect of the project. This framework will integrate expert evaluations with automated metrics to create a standardized method for assessing fossil image quality. Prototype Development will focus on creating a mobile application with real-time AI feedback. The prototypes will include different feedback mechanisms, such as text prompts and AR overlays, to test their effectiveness. User Testing will involve recruiting citizen scientists to participate in A/B testing. Surveys will collect feedback on their experience. Table 4.1 lists what activities and artifacts are in scope for this project.

Category	**Details**
Research	Literature review, expert interviews, and analysis of existing citizen science platforms.
Quality Framework	Development of a hybrid framework for evaluating fossil image quality.
Prototype Development	Web app with AI feedback (text prompts, AR overlays, or haptic feedback).
User Testing	A/B testing with citizen scientists; Survey on user engagement and satisfaction.
Deliverables	Proof-of-concept app, research paper, GitHub repository, and stakeholder presentation.

Table 4.1: In scope activities

To maintain focus, the following activities are excluded from the project: The project will not deploy a production-ready application. Instead, it will deliver a proof-of-concept prototype for demonstration and research purposes. No custom hardware, such as specialized cameras or sensors, will be developed or used. The prototype will rely on standard smartphone cameras to ensure accessibility for citizen scientists. While the prototype will include in-app guidance, the project will not develop long-term user training programs. The focus remains on the AI feedback system itself. The project will not include backend integration with another LegaSea sub-project being developed by a bachelor's student. The prototype will focus on frontend functionality, specifically the real-time feedback mechanisms. Finally, the project is focused on fossil imaging and will not explore use cases in other fields, such as flora or fauna documentation. These out-of-scope activities are listed in the Table 4.2.

Category	**Details**
Full-Scale App Deployment	The project will not deploy a production-ready app; only a proof-of-concept prototype.
Hardware Development	No custom hardware (e.g., specialized cameras) will be developed.
Long-Term User Training	While user guidance is included, ongoing training programs are not part of this project.
Integration with All Platforms	The prototype will focus on mobile (Android/iOS), but not full integration with LegaSea's backend.
Non-Fossil Use Cases	The solution is tailored to fossil imaging; other domains (e.g., flora/fauna) are excluded.

Table 4.2: Scope limitations

The project has several constraints due to its limited time and resources: The project must be completed by January 2026 to meet Fontys ICT deadlines. This timeline includes all research, development, testing, and reporting phases. User testing will rely on a small number of citizen scientists, recruited through Naturalis researcher Isaak Eijkelboom. The prototype will use React for mobile development and Python for AI components. Pre-trained AI models (e.g., Roboflow, PyTorch) and the already trained model by Oervondstchecker (*Oervondstchecker,* 2025) will simplify development. The project will rely on existing fossil images from Naturalis and Oervondstchecker. User testing assumes participants have smartphones and basic technical skills. The Table 4.3 lists these constraints.

Category	**Details**
Time	Project must be completed by January 2026 (Fontys ICT deadline).
Technology	Prototype will use React (web framework) and Python (AI).
Data	Relies on existing fossil images from Naturalis and Oervondstchecker.
User Access	Testing assumes participants have smartphones and basic technical skills.

Table 4.3: Project Constraints

Chapter 5

Project Deliverables

This project will deliver three artifacts. One is a proof-of-concept application, designed by considering user requirements and results of published research papers. This prototype should include a real-time camera mode within a mobile application that offers feedback while capturing an image—e.g., "move closer", "adjust lighting", or "include a scale". Choosing the technologies and how to achieve this is part of the initial research.

The second artifact is a research paper that answers the main research question. The paper will be structured according to the IMRaD (Introduction, Methods, Results, and Discussion) format and will include insights from the literature review, expert interviews, and end-user questionnaires. Finally, a public GitHub repository will contain the project's code, architectural diagrams, and detailed code and design documentation.

Chapter 6

Stakeholder Overview

The LegaSea 2.0 project brings together different stakeholders, each with specific interests and contributions. Scientific experts such as paleontologist Isaak Eijkelboom define the standards for fossil documentation and ensure that the research outcomes are scientifically valid and usable in ongoing studies. Educational stakeholders (Fontys lecturers and coaches like Gerard Schouten, Luuk, and Wouter) guide the academic quality of the project. They make sure the research follows proper methodology, meets program requirements, and contributes to learning goals. Product ownership and coordination are performed by Georgiana Manolache. She ensures that the project aligns with the larger LegaSea initiative. She has previously worked on the project and possesses knowledge and access to resources that help in the research. Students (Vince Colson, Sacha Ingemey, Calvin Zhen, and I) carry out the research and build a proof of concept. Finally, citizen scientists and end users are the most important external stakeholder group. Their needs, gathered through surveys and requirement analysis, show the demand for better image quality, real-time guidance, and accessible fossil information. They are the ultimate beneficiaries of this research. The various stakeholders are listed in Table 6.1, and Figure 6.1 displays the named individuals.

Stakeholder	**Role**
Isaak Eijkelboom	Paleontologist (Fossil Expert)
Gerard Schouten	Fontys Lecturer
Georgiana Manolache	Product Owner
Naturalis Biodiversity Center	Institute
Utrecht University	Institute
Fontys ICT	Institute
Vince Colson	Student
Sacha Ingemey	Student
Calvin Zhen	Student
Luuk Derkx	Fontys Coach
Wouter Boendermaker	Fontys Coach
Citizen scientists	End-user

Table 6.1: List of stakeholders and their roles

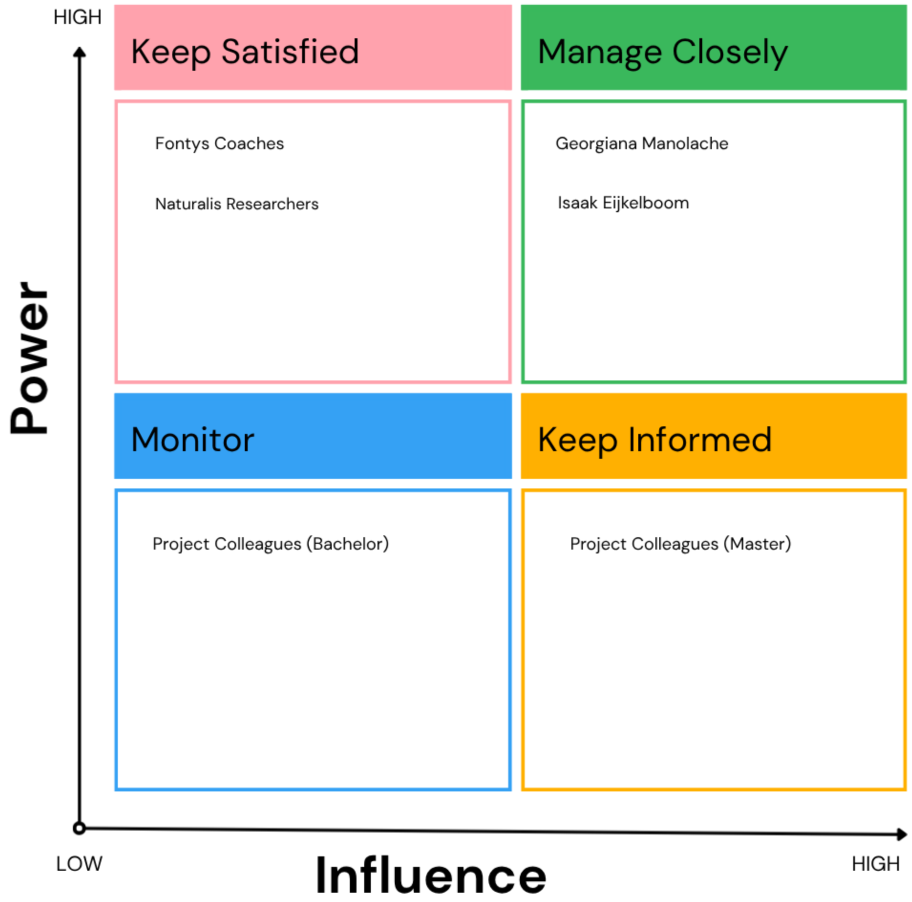

Figure 6.1: Stakeholder matrix

Chapter 7

Planning

Table 7.1 shows the milestones set by Fontys ICT, which will be reviewed by the Fontys coaches. They are used to track progress and help prepare for writing the final research paper.

Date	Description	Deliverable(s)
12.10.2025	Background Research	A written document was delivered to the portfolio. It includes detailed background research for each research question.
09.11.2025	Progress report	Documents progress in both project deliverables and learning goals.
30.11.2025	Ethical check	Using the TICT tool for a scan, hold a group discussion, review with the project owner, and write a report.
14.12.2025	Progress report	Update the progress report and share with stakeholders.
04/11.01.2026	Research paper early versions	Deliver research paper adhering to the IMRaD structure.
18.01.2026	Research paper final version	Deliver final research paper adjusted according to feedback.
21.01.2026	Achievement paper	Documents accomplishments for the semester.

Table 7.1: Milestones set by Fontys ICT program

This project began in September 2025 and ends in January 2026. At the start, a literature review and background research will be done to address the research question and its sub-questions. This phase aims to provide an understanding of the domain and help design the research and prototype. By November, active development of the prototype is expected to begin, and in December, the plan is to test the prototype with an end-user audience. After testing, the findings will be collected and presented in a research paper. Finally, there will be a handover of the project to ensure that it can be continued by another person without any issues. The following figure 7.1 visualizes this timeline.

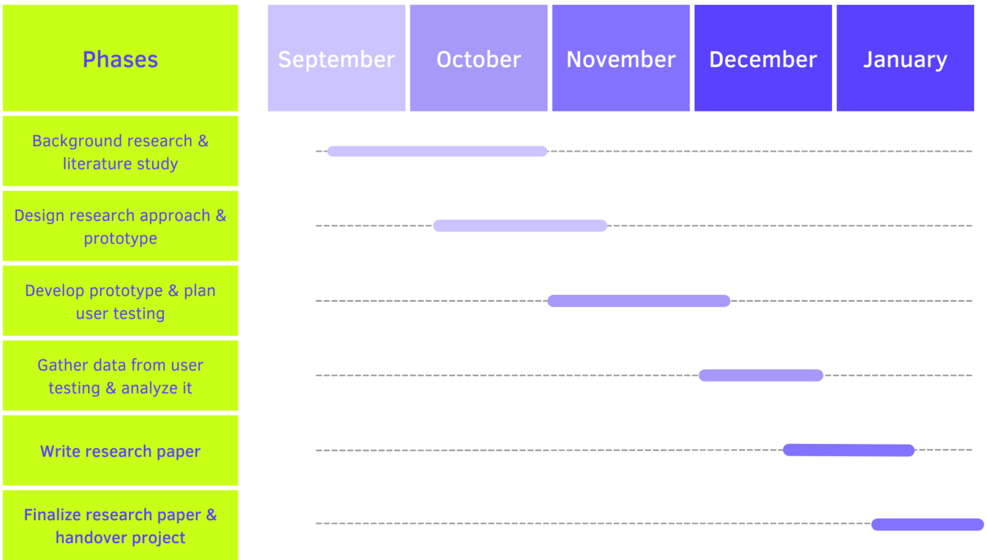

Figure 7.1: Project timeline Gantt chart

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Chapter 8

Appendix

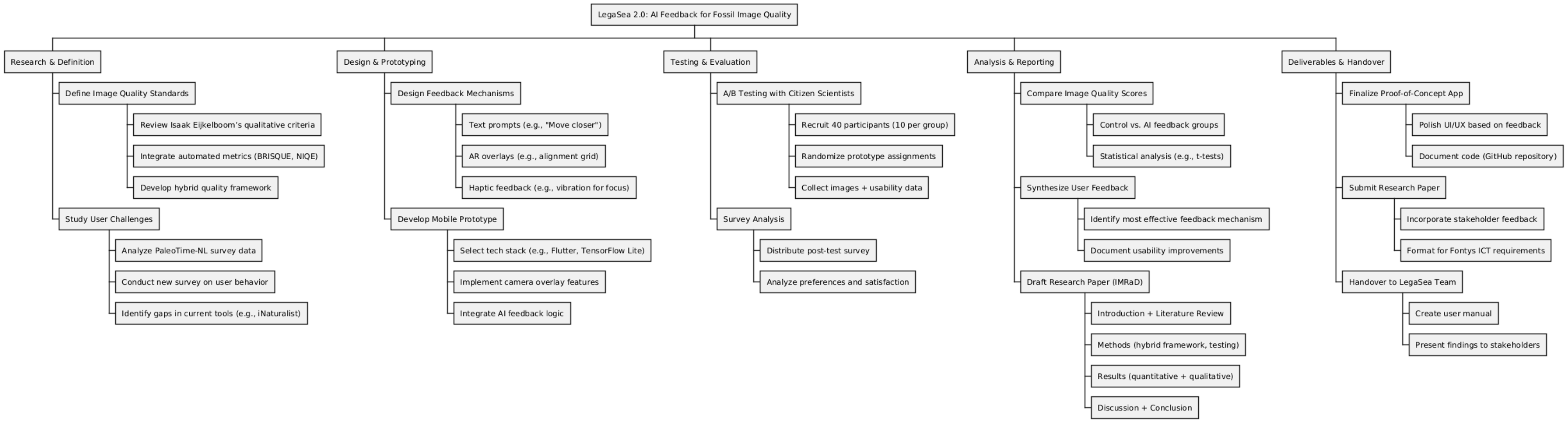

Figure 8.1: Work Breakdown Structure