Revitalizing the Past:
A user-centric redesign of an archaeology excavation app

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Keywords

Archaeology, Human-Computer Interaction, Web applications
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Abstract

This thesis conducts a comprehensive analysis on the field of archaeology, exploring its challenges and limitations towards a digital transition. Studies are conducted over a developed poc web application with the functionality to support storing and retrieving archeological logs regarding the artifact findings. These functionalities are continuously used and adjusted to cover and support the collaboration with the archaeologists from the IDIPOS team. Research techniques used in the field of Human-Computer interaction are being applied, reaching for improvements in the user experience and minimizing the gap on the Archeological logging procedures and the optimal user-centric web interface.

First part of research conducted within a week period at Prespes lake near Hellenic-Albanian border and part of it using online tools afterwards. Methods at some degree are covered in anarchy but wrap to the following. Direct observation, Interview, Document Analysis are conducted on the field to question whether the application meets the needs of its intended users while interacting directly from the excavation site. Online, a focus group and user story based on the notes provide a collaborative method involving users and stakeholders to define the user's journey in the application. Finally a think aloud study assigns predefined tasks to participants over the old and the new application to then analyze the exported data of the features in question.

Overall, the study enables the investigation of whether the application meets the needs of the collaborating archaeological team but also the field as a whole. It engages to communicate flaws on the proposed application and identify areas that may require further refinement. Additionally, the employed user story mapping assists on the development of a minimum viable product (MVP) approach, generating the relevant features to streamline the application development process, making it both cost-effective and efficient. To achieve this objective, the study delves into the design of the user interface (UI) over the proposed application poc, by following a user-centered approach and ensures that the final product has the necessary features and it's easy to use.
Evaluation and re-design of an archeological excavation application - Alexandros Skarmintzos

Abstract - Ελληνικά

Ηπαρούσαδιατριβήδιεξάγειμιαολοκληρωμένηανάλυσηστοντομέατηςαρχαιολογίας, διερευνώνταςτιςπροκλήσειςκαντουςπεριορισμούςτουπροςμιαψηφιακήμετάβαση. Διεξάγονταιμελέτεςσεμιαανεπτυγμένηδιαδικτυακήεφαρμογήροςμετηδυνατότητανα υποστηρίζειτηναποθήκευσηκαντηνανάκτησηαρχαιολογικώνευρημάτων.Οιλειτουργίεςτης εφαρμογήςπροσαρμοζόμεναγιανακαλύψουνκαναυποστηρίζουντησυνεργασίαμετους αρχαιολόγουςτηςομάδαςΙΔΙΠΟΣ.Εφαρμόζονταιερευνητικέςτεχνικέςπου χρησιμοποιούνταιστοντομέατηςαλληλεπιδράσησανθρώπου-υπολογιστή,καιεπιδιώκουννα εξαγόνταιβελτιώσειςστηνεμπειρίατουχρήστη,ναελαχιστοποιήσετετοχάσμαστις διαδικασίεςαρχαιολογικήςκαταγραφήςκαντηβέλτιστηδιεπαφήτουχρήστη.Τέλος,μια μελέτηανοιχτήςσκέψηςδυνατάαναθέτειπροκαθορισμένεςεργασίεςστουςσυμμετέχοντεςσε σχέσημετηνπαλιάκαιτηνέφαρμογήγιανααναλάβουνστησυνέχειαταεξαγόμενα δεδομένατωνενλόγοχαρακτηριστικών.

Τοπρώτομέροςτηςέρευναςδιεξήχθηεντόςμιαςεβδομάδαςερευνώνστηνλίμνητων Πρεσπώνκοντάσταελληνοαλβανικάσύνορακανέροςτηςμεχρήσηδιαδικτυακών εργαλείωνσεδεύτεροχρόνο.Οιμέθοδοισεκάποιοβαθμοκαλύπτονταιαναρχικά,αλλά αναλύονταιαποταεξής:Αμέσηπαρατήρηση,συνέντευξεις,ανάλυσηεγγράφων.Οτα αναφερόμεναδιεξάγονταιστοπεδίοκαιερευνώνεάνηεφαρμογήανταποκρίνεταιστις ανάγκεςτωνπροβλεπόμενωνχρηστώντηςοιοποιοιαλληλεπιδρούναπευθείαςαπότοχώρο τηςανασκαφής.Διαδικτυακά,διεξάγονται,μιαομάδαεστίασηςκαιμιαιστορίαχρηστών. Σημειώσειςπαρέχουνμιασυνεργατικήμέθοδοπουπεριλαμβάνειχρήστεςκαι ενδιαφερόμενουςνασυζητούνκανακαθορίσουντηδιαδρομήπλοήγησηστηνεφαρμογή.

Συνολικά,ημελέτηδίνετηνδυνατότηταναδιερευνηθείεάνηεφαρμογήανταποκρίνεταιστις ανάγκεςτηςσυνεργαζόμενηςαρχαιολογικήςομάδαςαλλάκαντοπεδίοσυνολικά. Εμπλέκεταιστηνκοινοποίησηελαττωμάτωνστηνπροτεινόμενηεφαρμογήκαντο πεπονισμόπεριοχώνπουενδέχεταινααπαιτούνπεραιτέρωβελτίωση.Επιπρόσθετα,η χαρτογράφησηιστοριώντωναπασχολούμενωνχρηστώνβοηθάστηνανάπτυξημιας προσέγγισηςελάχιστουβιώσιμουπροϊόντος(MVP),δημιουργώνταςτιςσχετικέςδυνατότητες γιατονεξορθολογισμότηςδιαδικασίαςανάπτυξηςεφαρμογών,καθιστώνταςτηναποδοτική
με μικρή περιοδο υλοποιησης. Για την επίτευξη αυτού του στόχου, η μελέτη εμβαθύνει στο σχεδιασμό της διεπαφής χρήστη (UI) πάνω από την προτεινόμενη εφαρμογή poc. Ακολουθώντας μια προσέγγιση με επίκεντρο τον χρήστη διασφαλίζει ότι το τελικό προϊόν είναι φιλικό.
Acronyms

POC - Proof of Concept
UI - User Interface
UX - User Experience
MVP - Minimum Viable Product
DB - Database

Artefact or artifact - Any object made or modified by humans, which is discovered during an excavation

Locus - distinct location or layer in an excavation site that represents a specific activity or time period

Loci - Plural of Locus
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Introduction

Archaeology, as a discipline, poses complex challenges, particularly in the recording and retrieving artifact data. The dynamic nature of excavation conditions creates difficulties in preserving critical information. Information that may only yield its relevance and value through analysis, often undertaken years later. Recent technological advancements have been applied to the field and inspire the development of application features that attempt to address the particular needs of archaeology.

Despite these efforts, a deviation is observed between the application's user interface and the specific requirements of archaeologists in the field, suggesting that the user experience is often suboptimal. Recognizing this issue, a collaborative effort by a team of developers led to the creation of a proof-of-concept (POC) application, which aims to cater more effectively to the needs of the archaeological team of IDIOPS.

The objective of this study is to apply principles from the field of Human-Computer Interaction (HCI) to enhance the user-centric interface of the POC application that can lead to a final product available for the field of Archaeology. To achieve this, a comprehensive analysis is conducted using a series of methods, including direct observation, interviews, document analysis, story-pointed focus groups and a think aloud through study that exports data through a 5-point Likert scale and open ended questions.

This dissertation is divided into sequential chapters, each with a distinct focus:

**CHAPTER 1**: Tech Transition in Archaeology – It explores the interaction between technology and archaeology. Highlights high value features that are included on the most known applications in the field.

**CHAPTER 2**: Literature Review – Investigates the existing academic literature related to this research. Sets questions and reaches for a gap in the field.
CHAPTER 3: Research Methodology – Mentioned details of each research method conducted throughout. Explains the research strategy and the methods employed for the optimal data collection and analysis.

CHAPTER 4: Findings – Presents and interprets the data collected throughout the study. A high level analysis of the results provided exported through each method, both on the field and online.

CHAPTER 5: Discussion and Future Proofing – It evaluates the implications of the findings. Driven by the gap found on the literature review, considers strategies for ensuring the application's future viability.

CHAPTER 6: Conclusion – It provides a summarization of the results throughout the research, highlights the key findings, considers the potential areas for further exploration and suggests features as good to have.

In the subsequent chapters, this study examines the intricate process of integrating technology within archaeology to improve user experience and application functionality. This comprehensive analysis contributes to the academic discourse intersecting archaeology and technology, hopeful to provide insights for future research.
CHAPTER 1: Technology transition in Archeology

1.1 State of the art

Archaeology, as a field intrinsically linked to the exploration and understanding of the past, has witnessed a major transformation over recent years. This transformation has been largely catalyzed by the evolution of technology, which has introduced a suite of sophisticated tools and applications designed not only for archaeological purposes still make procedures easier without being optimized for this field. This progress now enables archaeologists to carry out artifact recording, analysis and preservation with a level of detail and precision that was so far unachievable.

Before the introduction of digital tools, archaeologists primarily relied on manual methods for excavation, recording, and preservation of artifacts. The intricacies of these processes, coupled with the vast volumes of data generated from a single archaeological site, often presented significant challenges. Manual recording was a laborious task that not only demanded considerable time but was also prone to human errors. Moreover, the storage, retrieval, and analysis of this manually recorded data was a further complication, potentially inhibiting the extraction of maximum value from the collected information.

The incorporation of technology into archaeology has substantially simplified these processes. Cutting-edge tools and applications, designed with an understanding of the unique requirements of archaeology, now provide comprehensive solutions for data recording, analysis, and preservation. They enable the capturing of detailed data regarding the findings, facilitating an accurate and efficient record-keeping process. Subsequently, this digital data can be readily retrieved and subjected to a variety of analyses, unveiling insights that were previously concealed.

While the elementary technological tools offer functions such as artifact cataloging and data description, the more sophisticated ones boast advanced features. These might include, the ability to create three-dimensional models of the artifacts or to integrate with Geographic Information Systems (GIS) for the spatial analysis of archaeological data. Such features enable archaeologists to engage with the artifact data in more interactive and enlightening ways,
encouraging innovative approaches to archaeological interpretation.

Preservation, another vital aspect of archaeology, has also been significantly enhanced by technology. Capturing a three-dimensional model of artifacts ensures a form of preservation that is resistant to the physical degradation that artifacts invariably suffer over time. This ensures that even future generations of archaeologists have access to detailed records of these artifacts, irrespective of the fate of the physical artifact itself.

In essence, the ongoing technological revolution is shaping a new era in archaeology, endowing the field with enhanced capabilities for artifact recording, analysis, and preservation. Yet, this promising landscape is not devoid of challenges. Issues pertaining to the accessibility and affordability of these advanced tools, data security and the need for appropriate training in technology usage still needs to be considered.

These concerns necessitate an ongoing discourse in the field, aimed at maximizing the benefits of technology while minimizing its potential drawbacks. The subsequent sections of this chapter goes deeper into the technical specifications and capabilities of state-of-the-art archaeological tools and applications. In the next section technical features are broken down to themes highlighting what's being repeatedly seen and standardized across applications.[27]

1.1.1 Database Software:

Traditional database software with generic usage like Microsoft Access, is being replaced or complemented by more specialized software packages designed specifically for archaeological data. An example is the Archaeological Recording Kit (ARK), which is an open-source tool that allows for the recording, interpretation, and publication of archaeological data and interpretation online.

1.1.2 Geographic Information Systems (GIS):

GIS technology has revolutionized the way archaeological data is collected, stored, manipulated, and analyzed. ArcGIS and QGIS are some examples of GIS software used in archaeology. These systems allow archaeologists to perform spatial analysis and create detailed maps, enhancing their understanding of archaeological sites.

1.1.3 3D Modeling and Virtual Reality:
The incorporation of 3D modeling and Virtual Reality (VR) into archaeological practices represents the forefront of the field. These technologies allow for detailed visualizations and reconstructions of archaeological sites and artifacts. They also offer potential for public outreach and education, as 3D models and VR experiences can be shared digitally, making archaeological findings more accessible to the public. [17]

1.1.4 Mobile Applications:

With the proliferation of smartphones and tablets, several mobile applications have been developed to assist with archaeological fieldwork. These applications facilitate data recording in the field, often allowing for the direct input of data into a digital database, reducing the risk of transcription errors and increasing efficiency.

1.1.5 Machine Learning and AI:

Artificial intelligence (AI) and machine learning techniques have started to find their place in archaeology. These techniques can help in predicting archaeological site locations, analyzing complex data sets, and even identifying and classifying artifacts.

1.2 Existing applications

Various software applications have emerged and feature tools to support the archaeological work, presenting a paradigm shift in how archaeological research is conducted. These tools have demonstrated the potential to enhance efficiency, improve accuracy, and foster collaboration among archaeologists.

**iDig** - Allows archaeologists to manage their excavation projects in a collaborative and streamlined manner. It was developed by Bruce Hartzler, who has worked for the past 18 years as the IT Specialist for the Agora Excavations in Athens. iDig has been used in the Agora for four seasons and is being adopted by more international excavation teams every year. The platform provides the ability to create detailed excavation site maps, record excavation data in real-time, and manage artifacts and samples. Additionally, iDig allows for the creation of 3D models of artifacts, sites, and structures, enabling archaeologists to visualize and analyze the data in new
and innovative ways. The platform also includes features for managing budgets and team collaboration.

**CITiZAN** - Allows people to record and share their archaeological discoveries. CITiZAN, as a Coastal and Intertidal Zone Archaeological Network, highlights the threat of coastal erosion to a wealth of foreshore and intertidal sites. It provides an interactive map feature for exploring archaeological sites and learning about their history and significance. Users can upload photos, videos, and information about the artifacts or sites, which are then validated by professional archaeologists.

**Field Notes** - Created by Consultoria de Arqueologia Field Notes is a digital tool for android devices, designed to streamline the process of recording and organizing archaeological field data. The app features include the ability to record geolocation data, take photos, and record notes and observations. It also includes a feature for creating and managing digital site maps and drawings. Field Notes enables archaeologists to organize and manage their field data, making it more accessible and easier to analyze.

**ARK** Focuses on managing excavation data and creating 3D models of archaeological sites and artifacts. It also includes features for managing archaeological publications and archives, and for tracking research progress and collaboration across different teams and projects. ARK enables archaeologists to easily access and share their research data and collaborate with other researchers, making it a valuable tool for advancing archaeological knowledge and understanding.

**InTerris Registries** provides features for recording and organizing data related to archaeological sites and artifacts, as well as for managing site documentation, maps, and photographs. It also includes a geographic information system (GIS) feature that allows archaeologists to visualize and analyze data related to cultural heritage sites. It can work as a cloud environment for higher demands with a client server system in a computer network based on SQL databases. Additionally, the platform provides tools for managing and monitoring site conservation and restoration efforts.
These applications range from data collection and management systems to tools facilitating the visualization and analysis of archaeological finds. They introduce a new dimension of interactivity, allowing for real-time data input and retrieval, and thereby enabling archaeologists to conduct more informed and immediate analyses.

However, the development and adoption of these digital tools in archaeology is not without challenges. New technologies sometimes are hard to be implemented without a big code refactoring. Moreover, issues such as usability, accessibility, and the steep learning curve associated with some of these applications can be raised. The design of these applications may appear old and provide unique workflows and non customisable data management approaches of archaeologists. As such, there is a growing interest in the academic community to study and address these challenges, aiming to leverage the benefits of digital technology in archaeology teams.
CHAPTER 2: Literature Review

The understanding and successful implementation of any scientific research largely rests on an in-depth review of existing scholarly literature in the relevant field. This chapter, dedicated to the literature review, aims to explore the existing knowledge relevant to the transition of analog archaeological practices towards digital platforms and tools. It does an analysis of scholarly articles, research papers, case studies and other academic work to provide valuable insights into the subject matter, highlight research gaps, and help frame the methodological approach of the present study.

2.1 Introduction

The introduction of technology into the archaeology sector has transformed the way archaeological data is recorded, preserved, and interpreted. A growing body of literature testifies to this evolution while examining its implications from various perspectives. This literature review explores these topics in-depth, shedding light on the theoretical and practical aspects of archaeological software design and use. It does not limit itself to the positive aspects of technology implementation in archaeology. It considers the challenges and potential drawbacks, including issues related to accessibility, and data privacy. Furthermore, it critically evaluates how these challenges are being addressed in the current state of research and practice.

This chapter provides a comprehensive overview of the existing literature on the digital transition in archaeology. It aims to identify trends, highlight significant findings, and analyze the debates that currently exist in this field. In doing so, it lays a solid foundation upon which the subsequent chapters of this thesis will build up. The lessons learned from this review guide the methodological approach of the research, shape the analysis of its findings to ultimately contribute to the advancement of knowledge on the subject.

While reviewing the existing applications searching for the optimal UI/UX of the archaeological web app, the following research questions serve as a starting point for investigation, allowing for a deeper understanding of user needs that lead to design improvements and ultimately enhancing the usability and effectiveness of the final digital tool.
● Following the state of art, what specific needs, and pain points archaeologists continue to have when using digital tools for their work?
● Are there any standards for naming or codification used for creating these datasets?
● How can the app support collaboration among archaeologists, both within a team and across different archaeological projects?
● How can the web app be effectively designed to handle archaeological data?

2.1 Common field needs

2.1.1 Data Management

Effective data management is a critical component in archaeological work. The amount of data generated during archaeological expeditions, including field notes, photos, 3D models, soil samples, and other findings, is extensive. Managing this data efficiently helps in preserving, accessing, and analyzing it effectively.

Archaeologists require an organized system that facilitates data input, storage, retrieval, and manipulation. An excellent data management system ensures that data from different sources is appropriately integrated and provides researchers with the capability to perform comprehensive analysis. This includes drawing inferences about historical trends, comparisons, and other research aspects.

Moreover, a well-structured database aids in preventing data loss and maintaining the integrity of the information. It can provide valuable insights for future research, serve as an archive, and allow for cross-referencing with other studies. In the long term, effective data management can contribute to the development of a cumulative knowledge base in the field of archaeology. [4] [24]

2.1.2 Visualization and Analysis

Visualization and analysis tools are vital in the field of archaeology. They allow archaeologists to interpret and make sense of the collected data, as well as present their findings in a more understandable and engaging manner.
Data visualization in archaeology ranges from simple charts and graphs to more complex 3D models and virtual reality simulations. These tools can help in representing the spatial relationships and temporal changes in archaeological sites, presenting the findings in a more comprehensible and visually engaging way. For instance, a 3D model of an excavation site can give a clear idea of the spatial relationships among various structures or artifacts in the site, while a time-series visualization can demonstrate the changes in the site over time.

On the other hand, data analysis tools can help archaeologists process and interpret the vast amounts of data they collect. With the help of statistical analysis, pattern recognition, and predictive modeling, archaeologists can draw conclusions about the past societies they are studying. For instance, statistical analysis can help in understanding the distribution and frequency of certain types of artifacts, which can provide insights into the lifestyle, habits, and preferences of the people who used them.

Furthermore, the integration of artificial intelligence and machine learning technologies into data analysis can greatly enhance the efficiency and accuracy of archaeological research. AI algorithms can be trained to recognize patterns and make predictions based on the data, assisting in tasks such as artifact classification or site prediction.

Therefore, visualization and analysis tools are essential in archaeology for processing, interpreting, and presenting archaeological data, aiding in the understanding and reconstruction of past societies. [5][29]

2.1.3 Mobility and Field Usability

Mobility and field usability refer to the ability of archaeological tools and technologies to be easily used and transported in various field conditions. These tools should be lightweight, robust, and resistant to environmental elements such as dust, water, and extreme temperatures. Additionally, they should have a user-friendly interface that can be easily navigated even by individuals who are not particularly tech-savvy.

The primary need for mobility and field usability arises from the nature of archaeological work. Archaeologists often work in remote locations and challenging terrains where access to
traditional office equipment and facilities is limited. Therefore, the tools they use must be designed for portability and ease of use in the field. For instance, portable devices like tablets and smartphones equipped with GPS features enable archaeologists to record, analyze, and share data on-site, enhancing the efficiency of their fieldwork.

Additionally, tools with high mobility and field usability can facilitate real-time data collection and location mapping, allowing for immediate adjustments in excavation strategies and artifact when necessary. This feature can significantly enhance the effectiveness of archaeological expeditions and contribute to more accurate and timely findings.[6] [21]

2.1.4 Integration and Interoperability

The need for integration comes from the multi-faceted nature of archaeological work. Archaeologists utilize various tools and technologies - from GPS devices for mapping and locational data to databases for artifact cataloging, from 3D scanning tools for artifact reconstruction to statistical software for data analysis. Each tool generates its own set of data, often in unique formats. Integration allows these diverse data types to be consolidated into a central system, enhancing data accessibility, consistency, and management. For instance, an integrated system can enable researchers to easily correlate the locational data from a GPS device with the catalog data of an artifact found at that location.

Interoperability, on the other hand, refers to the ability of different systems and software to communicate, exchange data, and use the information that has been exchanged. This is especially important given the collaborative nature of archaeological work. Archaeologists often work in teams that may be spread across different locations, and they may also collaborate with other researchers, institutions, or even countries. Interoperability ensures that data and findings can be shared and accessed across different platforms, software, and devices, enhancing collaboration and the collective advancement of archaeological knowledge. For example, a database that is interoperable can allow researchers from different parts of the world to contribute to and access a shared pool of archaeological data.

Archaeologists often work with multiple tools and datasets, so they appreciate digital solutions that can integrate and share data seamlessly. Compatibility with existing databases,
interoperability with other software and formats, and support for data exchange and collaboration are important considerations. [7] [8]

2.1.5 Customizability and Adaptability

It refers to the ability of a tool or software to be modified according to the unique needs and requirements of each archaeological project and user. This is vital as archaeology encompasses a broad range of cultures, time periods, and artifact types, each with their own specificities that may not fit a one-size-fits-all solution.

Customizability allows users to tailor the functionality, interface, or output of a tool to fit their specific requirements. For instance, a customizable database may allow archaeologists to define their own fields for data entry, allowing them to capture the specific attributes of the artifacts they are working with. This enables more precise data capture, analysis, and interpretation.

Adaptability, on the other hand, is the ability of a tool or software to adjust to different situations or requirements. This could include handling different data types, working in various environmental conditions, or accommodating changing project goals or methodologies. In the context of archaeology, an adaptable tool may be able to handle data from different periods or cultures, adjust to varying field conditions, or accommodate new types of analysis or data as the project evolves. This ensures that the tool remains useful and relevant throughout the duration of the project, and can continue to support the archaeological work even as its focus or methods evolve. [9]

2.1.6 Data Security and Privacy

Data security and privacy are essential for any technology, including those used in archaeology. Given the sensitive nature of archaeological data, which can include details about undiscovered sites, precious artifacts, and human remains, it is paramount to ensure that this data is stored and transmitted securely.

Data security refers to the measures in place to prevent unauthorized access, use, disclosure, disruption, modification, or destruction of information. This could involve
encryption, access controls, and secure backups. For instance, a database containing details of archaeological finds may be encrypted to ensure that even if the data is intercepted, it cannot be understood without the decryption key. Access controls, such as password protection or user permissions, can be used to ensure that only authorized individuals can access the data. Regular secure backups can prevent data loss in the event of hardware failure, accidental deletion, or cyber attack.

Privacy is closely linked to data security, and refers to the right of individuals and organizations to control who can access and use their information. In the context of archaeology, this could involve ensuring that the details of sensitive sites are not disclosed to the public, or that information about human remains is handled with respect and dignity. This could involve anonymizing data, securing consent before sharing information, or implementing strict controls over who can access and use certain data.

Ensuring data security and privacy not only protects the integrity of archaeological work, but also fulfills ethical obligations to respect the privacy of the communities and individuals associated with the archaeological materials.[10]

### 2.1.7 Naming the datasets:

The naming of datasets in archaeology is a critical task for data management and organization. Properly named datasets enable researchers to easily identify and understand the contents of the data, facilitating smooth retrieval, use, and sharing of data among researchers.

In the context of archaeology, datasets could include data on artifacts, sites, strata, or any other type of archaeological information. An example for this is Dublin Core Metadata Element Set is a standard that provides a set of metadata elements that can be used to describe archaeological datasets. Each dataset has a unique and descriptive name that succinctly captures its content. The name should ideally indicate what type of data the dataset contains, where and when the data was collected, and who collected it. For instance, a dataset containing information on pottery fragments from an excavation in Rome conducted in 2023 by the XYZ Archaeological Team might be named "XYZTeam_Rome_Pottery_2023".
In addition to providing clarity, standardization in dataset naming is also important. Standardization facilitates consistency in how datasets are named, making it easier to sort and search for specific datasets. The use of a common language or naming conventions within a team, or even across the field of archaeology, can improve communication and data sharing among researchers.

It's also worth mentioning the need for metadata, which provides additional information about the data. Metadata can include a wide range of information such as the methods used to tag the data, the individuals involved in data collection, the time and place of data collection, and the purpose of the data collection. Metadata enhances the utility and understandability of the datasets, and thus should always accompany any dataset.

Therefore, proper naming and use of metadata are important for efficient data management in archaeology, enabling effective usage and sharing of valuable archaeological data. [S1][11]

### 2.2 Summary and gaps

The technological advancement in archaeology has brought out the development and adoption of crucial features in this field. Theming common needs in the previous section makes us understand that robust data management systems are indispensable for organizing, storing, and accessing vast quantities of archaeological information, thus streamlining analysis and collaborative work.

Secondly, given the mobile nature of archaeological work, tools that promote field usability are vital for enhancing productivity and data recording accuracy. The importance of system integration and interoperability can't be overstated either, they facilitate cross-functional communication and data sharing across different platforms. Customizability and adaptability also play a significant role in accommodating the specific needs of various archaeological projects. In addition, given the sensitive nature of archaeological data, the need for robust data security and privacy features is paramount. Proper naming and cataloging of datasets are vital for data retrieval and classification. Lastly, visualization and analysis tools help transform raw data into
understandable formats, thus aiding in interpreting and deriving insights from the data. Together, these features contribute significantly to making archaeological work more efficient and effective.

Focusing on visualization, user experience and usability are equally crucial, with clear navigation, consistent design patterns, and user-centered design principles playing a pivotal role in creating a positive user experience. Tools that minimize the learning curve and provide clear guidance and tooltips are highly valued.

Setting this as a gap, a thorough investigation into the usability and user experience (UX) of web applications in archaeology is needed to further enhance these digital tools. This includes delving into the challenges archaeologists face when using digital tools, identifying the specific functionalities and features that best serve their needs, and pinpointing the design considerations that can elevate their overall experience. In parallel, an examination of the cognitive processes, information-seeking behaviors, and decision-making patterns of archaeologists when interacting with web applications can yield valuable insights.

These insights inform design choices to optimize usability and enhance user satisfaction. Factors such as interface design, navigation structures, data presentation, data input methods, and task efficiency all play a part in this. Driving this research towards that and filling the research gap on the usability and experience of web applications designed for archaeologists can lead to the release of more effective and user-friendly tools. These improved tools can support and optimize current work, enhance data management and foster collaboration within the archaeological community.
CHAPTER 3: Research Methodology

These methodologies are guided by the gap in research followed by academics in the field. Adopts suited procedures to generate data and reach for the generated gap. With a POC application in hands the research is extended to real life usage. The POC is developed by a team of three developers, one designer and an archeologist with a DB integration background. It is a collaborative effort supported by the team of IDIPOS working on their archaeological research and providing valuable information by the time they arise. The real-world context of their work helps inform the platform's development throughout the process. [19]

3.1 The developed POC

Developed using the PHP Laravel framework for the backend, the application provides a robust and scalable solution solid for research and usage in the field. The frontend relies on the blade templating engine and Bootstrap css framework, ensuring a responsive and visually appealing user interface.

The app works well on desktop devices and offers a secure authentication system for users to sign up and log in. Users after logging in, gain access to their initialized excavation, where they can store artifact information set within Loci. Loci serve as cognitive silos for related artifacts, organizing the data efficiently. The platform features loci and artifact pages that store important technical details for archaeologists. Information is rendered in a table view, allowing users to easily view and sort the data. Additionally, actions such as editing and deleting are supported, enabling users to manage their findings efficiently.

3.2 Participants

Participants are professionals coming mainly from two different fields. Archaeologists are academic professionals involved in the excavation project near the Greek-Albanian border. They provide first-hand information about their experiences with the current digital tools and processes they use in their work. Their insights are critical in understanding the needs, preferences, and pain points.
Software Developers are the creators of the existing proof of concept (POC) application with a background in software design and development coming from their professional career. They provide technical perspectives and insights into the design, development, and maintenance of such digital tools. Receiving feedback from these diverse perspectives, the aim is to ensure a comprehensive understanding of the user requirements and technical considerations.

For the think-aloud study, to receive a large amount of quantitative data a more generic group of participants is recruited. People with even a basic understanding of web applications are suited enough to distinct a familiar interface going through predefined tasks.

3.3 Data Collection Methods

This stage embarks on a mission to address the fundations by evaluating the necessary features. The choice of the right methods for data collection occurred by the time and location available to collaborate with the team of archeologists at their working environment. Location varies for each method. Some conducted on the field or the lab, others online.

3.3.1 Direct observations

Direct observations offer a vital means of understanding user behaviors, preferences, and challenges within their natural contexts. This research method captures interactions as they occur in real-time, eliminating the risk of memory-related inaccuracies or post-event rationalizations.

Within the context, direct observations are leveraged to comprehend how archaeologists engage with the excavation app while conducting day to day tasks. It discovers their needs and identifies potential pain points in the current design. These observations occur within the users' natural working environment, thereby providing an unfiltered view of their typical interactions and experiences.

The methodological process involved defining the observation's purpose, pinpointing the target participants, crafting an observation guide, conducting the observation, and finally, analyzing the data. This observational method adds to the user-centric redesign of the
archaeology excavation app, enhancing its usability and ultimately, the efficiency and satisfaction of its users.

3.3.2 Interviews

Field interviews serve as a critical research tool, aiming to acquire in-depth insights into user behaviors, requirements, and attitudes. This method emphasizes dialogue and interaction, often taking place in the user's natural environment, thus allowing for a rich and nuanced understanding of the user's context and perspectives.

In the context of this thesis, field interviews are conducted with archaeologists to gain a comprehensive understanding of their experiences and expectations with the excavation app. The goal is to investigate their preferences, workflow, and challenges, capturing their suggestions for improvement.

The methodological approach involves defining the objectives of the interview, identifying the target participants, creating an interview guide with a list of questions or topics to cover, conducting the interviews, transcribing and anonymizing the collected data, and analyzing the results.

3.3.2 Document Analysis

Document Analysis is another vital research method employed within this study. This approach involves the systematic review and evaluation of documents—both physical and electronic—in order to extract meaningful data. These documents may be public or private records, printed or written material, or digital data such as emails, databases, websites, or software interfaces.

In the context of this thesis, Document Analysis is utilized to gain insights into the functional specifications, design considerations, and user feedback associated with the current archaeology excavation app. This can include review of technical documentation, user manuals, maintenance logs, user feedback reports, and any prior research or evaluation reports related to the app.
This method helps in understanding the historical development and current state of the app, identifying documented issues or limitations, and gaining insights into user interactions and experiences. The data gathered from the Document Analysis complements the findings from the Field Interviews and Direct Observations, and plays a significant role in informing the redesign process.

The procedure of Document Analysis involves obtaining relevant documents, conducting a careful review and evaluation, extracting and recording relevant information, and analyzing the data in relation to the research questions. As with other research methods, adherence to ethical considerations, such as respect for intellectual property and confidentiality, is a core principle in Document Analysis. [16] [20]

### 3.3.3 Focus group

Focus group is a research method in which the organizer conducts a meeting, with or without a physical presence on the premises, to discuss members' issues and concerns about their experiences with the application. One of the main strengths of focus groups is the ability to gather rich, qualitative data through the natural conversations and interactions that occur among the group members. This can lead to the emergence of new ideas, the validation or questioning of assumptions, and the identification of shared or diverging experiences and perspectives.

This meeting takes place online. At that point, a free discussion includes various aspects of the application. In addition to the topics discussed, screenshots of the application were shared, where specific use cases were presented and left participants free time for discussion.

Main benefit of focus groups is to discover what users want from the system, same with field studies. They both focus on investigating the needs of the system. A flowing discussion is needed and various perspectives. Typically, more than one focus group should run, as the outcome of any single session may not be representative and discussions can get sidetracked. [12]
3.3.4 Story mapping

User Story Mapping is a collaborative practice utilized by product teams to better understand their users' experiences and the flow of interactions with their product. It visually arranges the user's journey in a sequential manner, as they would experience it in the real world. The journey is broken down into individual user stories, which are essentially short, simple descriptions of a feature or functionality, told from the perspective of the user.

This narrative form allows teams to understand the nuances of the user's goals, motivations, and pain points, which in turn guides the creation of more effective and meaningful features. Each story in the map forms part of the user's journey, structured as a backbone sequence of activities that the user goes through, and then broken down further into tasks and subtasks.

The primary aim of a User Story Map is to create a shared understanding of the user experience amongst the team, enabling them to make more informed decisions about the development priorities, design, and product strategy. It essentially provides a 'map' for the product's evolution, ensuring that every development step adds real value to the user's experience. [14]

3.3.4 Think aloud

Conducting a think aloud session is particularly beneficial because it gives the researchers a unique opportunity to observe the users' thoughts, decision-making process and problem-solving strategies in real time as they interact with the system. Users are able to verbalize their thoughts, feelings and perceptions while using the product, thereby providing researchers with an in-depth understanding of the user's experience.

In the context of this research, the think-aloud method is implemented as an essential tool to better understand the interaction of users with the redesigned archaeology excavation app.

The think-aloud method is instrumental in identifying usability issues that may not be apparent through observation alone. It provides direct access to the user's thought processes, including their expectations, misunderstandings, and difficulties. Moreover, it allows for
immediate feedback on the user interface and the app's functionalities, enabling the research team to iteratively improve the app's design based on real user experiences.

The implementation of the think-aloud method requires careful planning, including the selection of participants, task definition, and data recording. The direct, unfiltered feedback obtained through think aloud can be instrumental in identifying usability issues, understanding the users' expectations, and uncovering areas of confusion or difficulty, which are not always apparent through traditional user testing methods. Thus, conducting a Think Aloud is critical in guiding the design and improvement of a user-centered product or system. [15]

3.4 Data Analysis

The analysis of field study and observational data often involves qualitative methods such as content analysis and thematic coding. Field notes, video recordings or other types of data captured are systematically reviewed to identify patterns, behaviors, and themes. This helps uncover important insights about how users interact with the web application in their natural setting. Additionally, visual data presentation methods are also used to further summarize and illustrate the observational data. In our case interview data were transcribed into written or electronic format to identify key themes in participants' feedback. Communicate the findings and implications to stakeholders, using visual aids.

Focus group, Interview data and documents are also transcribed and analyzed using thematic analysis. This involves coding the data, identifying common themes, and interpreting the significance of these themes in relation to the research questions. Regarding the focus groups, the interactions between group members can provide additional insights and should be considered during the analysis.

Analysis of user story mapping sessions involves categorizing and prioritizing user stories based on various factors such as user needs and business value reaching for an MVP. It might also involve identifying dependencies or relationships between different user stories. The outcomes can inform the design and development process of the web application.
For all these methods, data triangulation can be considered. Using multiple data sources or methods to cross-verify findings ensure the validity and reliability of the findings.

3.5 Limitations

This study, like many others, does not come without its limitations. First, the methodology chosen relies heavily on the subjective input and experiences of individuals, which inherently presents a challenge in maintaining the uniformity and objectivity of collected data. The responses gathered through interviews, focus groups, and field observations can vary greatly based on the respondents' perspective, personal biases, and interpretation of questions or scenarios. Although this qualitative approach can provide rich, nuanced insights into user behavior and needs, it also introduces potential inconsistency and subjectivity into the analysis.

Lastly, while the focus group and user story mapping methods facilitate robust interactive discussions and collaboration, they may not fully capture the complexity of real-world use cases and workflows. Users may not accurately or entirely recall their experiences, needs or challenges during these sessions, leading to potential gaps in the final outcome. Despite these limitations, the methodology is designed to yield valuable insights into the user-centric design and evaluation of an archaeological excavation application. However, the findings should be interpreted with an understanding of these limitations.
CHAPTER 4: Results/Findings

As mentioned in the previous chapter, a plethora of methods is conducted both in the field, the lab and online. A field study to observe and theme participants’ feedback. Interviews to expose important features. Document analysis to align with the technical terms and cover already defined requirements. Focus group to align our decisions and get feedback from the users. A Story mapping to define the user's journey. And think aloud letting participants compare the POC and redesigned UI.

4.1 Direct observations

Direct observations take place regularly throughout the week to capture how participants interact with the prototype app and everyday excavation tasks accordingly. This field study is conducted in the natural setting of an active archaeological excavation. Used as an opportunity to observe and document the interactions, behaviors, and practices of archaeologists as they navigate their work using digital and analog tools. Throughout the direct observations conducted, a number of key findings emerged that contribute to understanding the current work processes and the challenges faced by the archaeology team on-site.

Firstly, insights are recorded from the terminology used within the team. Terms such as depth, locus, locus extension, level are frequently encountered during the observation. These terms have specific meaning in an archaeological context and are crucial for accurately documenting and interpreting the findings. Sorting these common terms by usage within the period, we understand the weight of the reference within the platform.

In relation to artifact handling, it is noticed that important information related to an artifact is tagged and linked within each artifact stored in a bag. This highlights important tags attached to each entity that are used for sorting. Furthermore seeing these bags organized within the context of a locus we are able to understand the relevance generated between each artifact. Another detail is shown on Figure 1. where special objects are stored as a standalone group.
Moreover, it is noted that photo IDs are attached to each locus, signifying the importance of visual documentation in archaeological work. Hence, the application should provide robust support for integrating and managing photographs related to each locus.

Observations also reveal that soil characteristics, including color and texture, play a significant role in defining the archaeological layer and the associated historical context. As shown on Figure 2 different layers represent different historical era, it is crucial for the application to facilitate easy recording and visualizing within these stratigraphic contexts.

These observations provide valuable insights into the practical needs and constraints of archaeological fieldwork. Coupling this understanding with subsequent document analysis, provides a comprehensive perspective to guide the further development and optimization of the application. This realization paves the way for the upcoming section of this research, which delves into the comprehensive document analysis, the formal procedures and requirements within the realm of archaeology and refine the application's features and functionality accordingly.
Figure 1. This photograph showcases the Special object artifacts at the archaeological site with labels containing data for artifact storage. Maligrad 2022

Figure 2. Archaeological layers tagging the age of different soil. Maligrad 2022
Perspective Notes

On-site

- Day begins and ends with measuring degrees with a compass
- Akis writes on a calendar. Each day has logs on the right and free art in the left page.
- Detailed abstract notes are being recorded, in order to be merged later.
- The excavation level of one locus may differ from the adjacent locus, even if they are apparently at the same height. A grave may have been dug and the dead entered at an earlier level.

Warehouse

- Panos and Akis check some boxes to make sure they have the artifacts they have listed in excel

Figure 3. Part of direct observation notes. Maligrad 2022.

4.2 Document Analysis

Document analysis reveals numerous areas for potential digital transformation. The archaeological team provided documents with detailed terminology. Database structure of an older approach to a digital archive was recorded. Photos of the analog calendar book were also used.
Legends provide the terminology within the field, an important reference for terminology to be aligned with the text within the app and provide an easier reference while interacting.

Furthermore, the analog calendar logbook currently logs artifact numbers, contexts of findings, and dates. It appears to be a prime candidate for digitalization. Converting this repetitive, daily logging task into a digital format could significantly improve efficiency and accuracy.

The treatment of loci and their associated artifacts stand out as an area for potential digital improvement. Currently, these artifacts are analyzed based on their characteristics and recorded in an analog format. This method helps log but does not offer any statistical information about the amount of material present in a specific location, nor does it provide an easy to calculate summary of the excavation. Transferring this process to a digital format could provide more comprehensive and accessible data, ultimately aiding in the analysis and understanding of the excavation site.
Figure 4-5. On the left a calendar view of revealed artifacts. On the right, legend of different possible materials. IDIPOS Team.

4.3 Interviews

This section presents the key findings obtained from the interviews conducted both in the field of excavation and the laboratory. The interviews are designed to be supportive and avoid creating a bias, facilitating an open dialogue with the interviewees. Conducted at the one-week period to gather participant feedback on their experience with the prototype. Part one of the interview conducted on the field, part two at the end of the day in the lab, while actively interacting with the digital POC.

4.3.1 Field interviews

In the field of excavation, an interview is conducted with the Archaeology Coordinator using audio recording. When asked if they would use the application in its current state, they mentioned connectivity issues, saying "The internet coverage on this location is low." There was also a side note about the environmental conditions affecting usability: the sunny weather made it difficult to read screens in direct sunlight.

In another comment, a local archaeology researcher raised questions about data security in the application, asking "Is data storage secure?". Data privacy and security is a concert that needs to be communicated with the users.

4.3.2 Laboratory Interviews

The second part of the interview was conducted at the laboratory with the Archaeology Coordinator this time using notes. When asked about the challenges they experienced while using the application, they provided several points for improvement.
Firstly, a concern is that the application’s current focus is on clay artifacts. He expresses a need for the application to support forms for different types of material. The interviewee also expressed a preference for the app to function more like a calendar and to store data in a manner similar to that. When browsing a locus, they wanted the ability to see relative loci.

In addition, the Archaeology Coordinator mentioned the necessity for exportable statistical reports from the application. These findings from the interviews shed light on the real-world needs and challenges faced by users, guiding further refinement and development of the application.

**Interviews**

**Requests**

- More data in the forms with statistics
- Better filters
  - straight lip, horizontal lip
  - All coins from layer 5
- Offline mode
- Show photo of the clicked abstract
- Missing form inputs
- Need a way to export statistics and make conclusions

Figure 5. Interview notes. Source: Author's own image.

**4.4 Focus group**
Online meetings provide valuable feedback about the current POC. Focus group discovers what users want from the system. The conducted focus-group session felt free-flowing and relatively unstructured, nevertheless it followed a preplanned path of specific issues and set goals for the type of information to be gathered. Participant's opinions domination tried to be avoided. Six participants take part in the session.

One interviewee noted the need to adjust forms interactively, based on the type of material being logged. Another key point raised is the necessity for statistical exports and more detailed research. Additionally, interviewees identified the importance of filtering capabilities, especially when dealing with long data tables. This suggests a key area where user interface and experience can be improved.

A second statement in the suggestion to incorporate a calendar feature in the platform. As one participant shared, "having a timeline documentation of an excavation, possibly through a calendar, could be a valuable feature." The inclusion of a calendar function would not only aid in project management but also provide a chronological context for the artifacts, an aspect that is a significant part of the cognitive model a user has already set.

The focus group also identified the need for an offline mode, which was underlined by several participants. One participant noted, "the internet connection at the excavation sites can be quite unstable. Having an offline mode in the app would be highly beneficial." The addition of this feature would ensure that the functionality of the application is not hindered by internet connectivity issues, allowing archaeological work to proceed.
**Focus group**

Notes:

- A calendar is important timeline documentation of an excavation. Replicating this on the platform
- Offline mode is an important feature to add. On the excavation site internet connection is unstable
- There is a need to adjust forms interactively, based on the type of material being logged

Figure 6. This is a final filtered view of most important notes after the focus group session.

Source: Excavation development Team.

**4.5 User Stories**

**4.5.1 Personas**

The story mapping session offers rich insights into the various user types and their specific needs.

First, they promote a user-centered perspective, ensuring that the needs and preferences of archaeologists are central to our application's design and functionality. This focus allows us to tailor the digital tools and resources to the specific contexts and tasks, thereby enhancing their workflow's effectiveness and efficiency.

Second, personas serve as valuable communication and consensus-building tools within our research team and developers. They provide a shared understanding of our user group, eliminating any ambiguity or misconceptions about their characteristics, needs, and preferences. This shared understanding facilitates collaboration and coordination in our design and development activities.

Third, by providing insights into the motivations, behavior, and needs of archaeologists, personas guide our decision-making processes. They inform the prioritization of certain features
and design elements, helping us determine what aspects of the application will provide the most value to archaeologists. The empathetic view that personas cultivate within our team allows us to see our application from the perspective of its users. This empathy is crucial in crafting an application that is intuitive, satisfying, and effective for its users.

Finally, personas increase the efficiency of our design and development process. By informing our design decisions early in the process, they minimize the risk of extensive modifications later on, saving time and resources.

In summary, the use of personas in this thesis significantly enhances our ability to design and develop an application that meets the specific needs and preferences of archaeologists, facilitating their critical work.

As part of this process, distinct personas were created. It includes the Archaeology Coordinator, Student, Exclusive Researcher, and Visual Assistant. [22] [23]

<table>
<thead>
<tr>
<th>Persona Name</th>
<th>Archaeology Coordinator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30-50</td>
</tr>
<tr>
<td>Profession</td>
<td>Archaeologist, possibly academic</td>
</tr>
<tr>
<td>Role</td>
<td>Manages archaeological excavations, records and manages site data, potentially analyzes findings.</td>
</tr>
<tr>
<td>Key Characteristics</td>
<td>Experienced, organized, analytical.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Persona Name</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18-30</td>
</tr>
<tr>
<td>Profession</td>
<td>Archaeology student</td>
</tr>
<tr>
<td>Role</td>
<td>Learns the process of excavation and data recording, records findings under supervision.</td>
</tr>
<tr>
<td>Key Characteristics</td>
<td>Eager to learn, tech-savvy, enjoys VR technology and podcasts in</td>
</tr>
</tbody>
</table>
### Persona Name

<table>
<thead>
<tr>
<th>Exclusive Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 30-50</td>
</tr>
<tr>
<td>Profession</td>
</tr>
<tr>
<td>Anthropologist, researcher focused on a specific aspect of analysis.</td>
</tr>
<tr>
<td>Role</td>
</tr>
<tr>
<td>Analyzes findings, adds interpretive notes to existing records.</td>
</tr>
<tr>
<td>Key Characteristics</td>
</tr>
<tr>
<td>Specialized, meticulous, analytical, not necessarily an archaeologist.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Visual Assistant (Photographer, Designer, Drone Pilot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 20-40</td>
</tr>
<tr>
<td>Profession</td>
</tr>
<tr>
<td>Photographer, designer, drone pilot.</td>
</tr>
<tr>
<td>Role</td>
</tr>
<tr>
<td>Captures and manages visual data from the site, stores media related to findings.</td>
</tr>
<tr>
<td>Key Characteristics</td>
</tr>
<tr>
<td>Tech-savvy, good at operating drones and photography, potentially does professional or hobbyist photography outside of work.</td>
</tr>
</tbody>
</table>

Figure 7. This sheet showcases Personas generated to be used within the Story mapping process. Google Docs.

### 4.5.1 Story mapping

User Story Mapping, an efficient and strategic tool in product development, plays a significant role in the process of redesigning the archaeology application. This method provides a structured and flexible approach to understand the user needs, organize ideas and prioritize features based on user profiles and their interactions.

To frame the application's functional requirements, we focus on four primary personas: Archaeology Coordinator, Student, Exclusive Researcher, and Visual Assistant. These personas
represent a broad spectrum of potential users who will interact with the application in unique ways, each with their own set of activities.

The first activity, "Add New Artifact", is a central operation that all personas might perform. The Archaeology Coordinator and the Student, who are directly involved in the excavation process, may frequently utilize this step to update the database with new discoveries. The Exclusive Researcher, though not directly adding artifacts, may provide crucial information to enrich the existing records.

The second activity, "Retrieve Artifact Information", is essential for almost all personas. This function enables the Archaeology Coordinator and Student to recall previously recorded information, crucial for continuity in their work. The Exclusive Researcher relies heavily on this feature for analysis and study purposes, while the Visual Assistant uses it for media tagging and association.

The third activity, "Add a Photo to Artifact", is particularly important for the Visual Assistant, who is responsible for visually documenting the findings. This feature, however, is also used by other personas. For instance, the Archaeology Coordinator may utilize it during onsite documentation, while the Student might use it during secondary activities.

The User Story Mapping process allowed us to dissect these activities into manageable chunks, understand the user journey, and align the app's features with user expectations. By focusing on these specific activities, we ensured the application caters to the personas' needs, thus enhancing the user experience and the overall utility of the app. This process underscores the interplay between the design, the utility of the application, and the end-users, providing an optimized platform for archaeological data management.
The Story Mapping process provided a brainstorming phase, during which several potential enhancements emerged that could be integrated into future updates. These developments, born out by identifying the needs of the diverse user personas and activities and create a more personalized user experience.
Firstly, adjusting the user type interface and rules became a clear necessity. This enhancement tailors the user interface based on the role of the user, whether a coordinator, a student, an exclusive researcher, or a visual assistant. This level of customization would streamline their individual workflows and ensure a more intuitive, user-friendly experience.

Adding new artifacts on-site is another functionality identified as a prospective improvement. This feature would permit archaeologists to record findings in real-time during excavation, improving data accuracy and efficiency.

In addition, the need for a filterable table was highlighted. This would allow users to manipulate data display and access specific information more rapidly, thus enhancing the application's usability.

Moreover, the integration of a 3D view of the excavation site surfaced as a valuable addition. This visual feature would provide a dynamic and comprehensive view of the site, thereby aiding users in data interpretation and site understanding.

Furthermore, the ability to download statistical export is also identified. This feature will provide users with the capability to extract statistical data from the application, facilitating data sharing and further analysis.

Finally, the ability to upload a 3D model of an artifact was deemed a promising improvement. This would offer a more detailed and tangible representation of the artifact, thereby enhancing data interpretation and comprehension.

All these proposed improvements underscore our commitment to evolving the application to meet the shifting needs and expectations of its users. By continuously integrating user feedback and findings from such processes as User Story Mapping, we strive to create an application that truly serves its purpose as a comprehensive tool for archaeological data management.

**4.6 Think aloud**
There are a lot of advantages using the think aloud method. Most importantly, it serves as a window on the mind, letting scientists discover what users really think about a design. In particular, misconceptions emerge, which usually turn into actionable redesign recommendations: when users misinterpret design elements, they need to be changed. Additionally, it helps understand why users guess wrong about some parts of the UI and why they find others easy to use.

Think-aloud protocol serves as an invaluable tool in user testing methodology. It is useful in identifying potential usability issues, giving rise to solutions tailored to improving the user experience. The protocol is also instrumental in revealing any misconceptions or assumptions users may harbor regarding the product, which might not be foreseen by designers or developers.

On top of providing valuable insights, the method validates design decisions through positive user feedback and seamless interactions, affirming the intuitiveness and user-friendliness of the user interface. Notably, it is cost-effective and less time-consuming compared to some other user research methodologies. The flexibility of the method allows its application at any stage of the design process, from preliminary prototypes to fully operational products, and across a multitude of interfaces such as websites, software applications, and mobile apps. However, like any other method, it's crucial to incorporate think-aloud protocol as part of a comprehensive mix of user research methods to obtain the most accurate results. Thus is conducted as a final procedure after the research on the field.

4.6.1 Participants

Participants who represent the user base were recruited. These are the ones who are analyzed as personas in the section above. Archaeology Coordinator, Students, Anthropologist/Researchers, Perspective Assistant.

4.6.2 The Environment

The Think-Aloud evaluation in this research is conducted digitally, offering a distinct advantage where in-person gatherings can be a challenge. The participants have sent detailed instructions through an email form, explaining the procedure and what is expected of them. This
digital approach allowed for more flexibility and convenience for the participants while ensuring a structured process for data collection.

The tasks to be performed by the users is clearly highlighted, focusing on both the existing and the newly proposed user interface. This allowed for a direct comparison of the user experience between the old and new versions, providing valuable insights into how the changes impact user interaction, efficiency, and overall satisfaction.

To streamline data collection and make the analysis process more manageable, a Google Form is utilized. Participants fill out this form during their Think-Aloud session, recording their experiences, thoughts, and any challenges they face while navigating through the tasks. This method of data collection not only provided a structured format for users to input their experiences but also facilitated the subsequent process of data analysis by providing a consolidated and organized set of data.
**Excavation App redesign survey**

Thank you for participating in the survey. Your input is much appreciated as we develop this application.

We want to hear your feedback so we can improve the interface. Please fill in this quick survey and let us know your thoughts (your answers will be anonymous).

Please rate from Very Poor to Very Good.

1. What was your initial impression of the updated UI when you first opened it? *  
   Very poor ○ ○ ○ ○ ○ Very good

2. What is your feedback on ‘selecting a locus and viewing the artifacts it contains’? Did you find any difficulties or easy to use steps?  
   Map does not provide tools to interact

3. How intuitive was the new interface when using LOCUS PAGE? *  
   Very poor ○ ○ ○ ○ ○ Very good

4. What is your feedback on ‘viewing the artifacts associated with the selected locus’? Did you find any difficulties or easy to use steps?  
   Your answer

5. How was your experience retrieving artifact information from the ARTIFACT PAGE *  
   Very poor ○ ○ ○ ○ ○ Very good

6. What is your feedback on ‘interacting with a new artifact using the interface provided’? Did you find any difficulties or easy to use steps?  
   Your feedback

7. How would you rate the field grouping on the ADD ARTIFACT page? *  
   Very poor ○ ○ ○ ○ ○ Very good

8. If you had to use this app regularly, how would you rate its overall functionality and user experience?  
   Very poor ○ ○ ○ ○ ○ Very good

9. Did you encounter any difficulties or confusion in general while using the updated UI? Please describe below.  
   Map fully empty

Name (optional)  
Sofia

Submit

Clear form

*This content is neither created nor intended by Google - Data Abuse - Terms of Service - Privacy Policy*
Figure 8. Think aloud 5-point likert scale and questions. Source: Google forms.

4.6.2 Conducting the Session

Procedure explanation is communicated through email invitations. Tasks are generated to guide participants through predefined framed scenarios. Participants are prompted to note their thoughts as they perform each task. During the session, participants observe and navigate, then they follow the requested tasks. Here’s the assignment structure.

Dear Participant,

As part of the commitment to improving the user experience on the examined archaeological web application, a Think-Aloud study is conducted and would like to invite you to participate. The aim of this study is to gather insights about the usability of the new design, as well as identify any potential areas for improvement.

To participate, you would need to complete a set of tasks using our web application while verbalizing your thoughts, opinions, and any difficulties encountered. No special skills are needed or knowledge to take part, just a willingness to explore and share your experience.

THINGS TO KNOW

LOCUS PAGE Lists all silos that contain artifacts

ARTIFACT PAGE Lists all artifacts of a selected Locus (silos)

ADD ARTIFACT Standalone page to let user add new artifact

STEP 1

Familiarize yourself with the screenshots below, showing the old design of the application
STEP 2

Follow the clickable navigation of the redesigned Excavation App using the link below. Within this interface you will have to cover the five tasks that follow.

Figma Interactive Interface url

Clicking on white space, clickable areas are highlighted and can be navigated.

Take your time to explore these, and once you've finished, click the logo in the upper left to return to the starting page.

Tasks:

1. Familiarize yourself with the redesigned web application.

2. From the main page, select a Locus and view the artifacts it contains.

3. Investigate the artifacts presented in the selected Locus.

4. Finally, attempt to add a new artifact using the interface provided.

5. Click the logo to go back to the starting page

While completing these tasks, please share your thoughts out loud. Your feedback is invaluable to us as we strive to make our application more user-friendly and effective.

STEP 3

Once you've completed the tasks, please fill out the provided Google Form to record your experiences and thoughts.

https://forms.gle/x24zNnunzg15DUda6

Your participation is voluntary and greatly appreciated. If you choose to participate, please be assured that your responses will remain confidential and will be used only for the purposes of this study.

Thank you for considering this request. We look forward to your valuable feedback.
Best regards,

Alexandros Skarmintzos

HCI Research

Figure 9. This is the email sent to the participants to support the think aloud online.

4.6.3 Data Analysis and Reporting

Participant responses are divided into two types, open-ended and Likert Scale quantitative data. Open-ended questions offer significant advantages in user research as they allow participants to express their views, thoughts, and experiences in their own words. Unlike closed-ended questions, they do not limit responses to selected choices. This makes open-ended questions an excellent tool for exploratory research where the aim is to uncover the range and depth of users' experiences. Likert scale questions, on the other hand, provide a set of fixed choice responses from which respondents can choose their answer. The benefits of using Likert scale questions are numerous. Firstly, they allow for the quantification of subjective experiences, making it possible to analyze user feedback statistically. This leads to more robust conclusions about a larger user population. Secondly, they provide a straightforward way for respondents to express their opinions, which can improve response rates. Lastly, it allows to measure the intensity or degree of the respondents' feelings, making them useful for assessing user attitudes or levels of satisfaction.

Open-ended questions provide qualitative data that need meticulous handling. The analysis is typically initiated with a thematic analysis where the collected responses are read and re-read to gain a thorough understanding of the data. During this process, common themes or patterns are identified. Once these themes are discerned, they are coded for easier recognition and organization. Each response is categorized based on the previously identified themes. Codes are applied to appropriate segments of the data, thereby streamlining the interpretation process. Lastly, interpretation of results takes place. It involves comprehension of the implications of the identified themes in the context of the research objectives. These themes contribute significantly to outlining the participants' overall experiences and perceptions.
Likert scale questions, on the other hand, generate quantitative data. The analysis process is more structured and statistical. First, numerical values are assigned to each response choice on the Likert scale, facilitating quantitative analysis. For instance, on a scale of five, 'Strongly Disagree' might be assigned 1, while 'Strongly Agree' might correspond to 5. Next, descriptive statistics are calculated. Mean scores, modes, medians, and even standard deviations for each question can be computed to get a sense of the overall trends and variations in the data. Frequency analysis might also be performed to understand the frequency distribution of each response. In cases where demographic or other categorical data is collected, cross-tabulation can be beneficial to identify if there are significant differences between groups. For instance, analysis might reveal differences in responses between men and women to a particular question. Notably, though Likert scale data is often analyzed using methods for ordinal data, treating it as interval data is a common practice in many social science fields. However, this practice does involve an ongoing debate, and the researcher should make choices that are appropriate for the specific study and field.

4.3.4 Open-Ended Questions thematic analysis

The thematic analysis of open-ended questions from the Think-Aloud study provided insights into users' perceptions and experiences of the redesigned web application. Five major themes emerged from the analysis.

**New UI was pleasing to the eye** - Many participants remarked positively about the aesthetics of the new user interface. Comments related to this theme highlighted the attractiveness, clarity, and modernity of the design. Participants noted the color scheme, use of images, and the layout as key factors contributing to an appealing visual experience. This theme suggests a positive first impression and the value of aesthetic appeal in user engagement.

**Interaction with the app feels familiar** - The participants often compared their interaction with the application to their experiences with other digital platforms. Many noted that navigating the site felt intuitive and that the features and layout were reminiscent of other commonly used interfaces. This theme highlights the importance of leveraging existing digital literacy and habits in web app design.
Add artifact page requires too many fields - Some participants voiced concerns about the number of fields required when adding a new artifact. They described this process as cumbersome and time-consuming, suggesting the need for a simplified data entry process. This theme indicates a potential area for improvement in streamlining user interactions.

Loci Page Map does not provide tools to interact - A number of participants noted that the Loci Page Map lacked interactive features. They expressed interest in having more tools to interact with the map selecting multiple loci, and more. This theme emphasizes the value users place on interactive visual data representation.

Artifact page is missing filtering options - Participants noted that the artifact page lacked filtering options, limiting the utility of the page. They expressed a desire for more flexible and efficient ways to navigate the artifact data. This theme points towards an opportunity to enhance the user interface with more advanced data navigation tools.

These findings provide useful insights into user perceptions of the redesigned application and suggest areas of focus for future refinement.

4.3.5 Interpretation

UI Aesthetics (Theme: New UI was pleasing to the eye) - This code refers to participants' overall appreciation for the visual design of the web app. The interpretation suggests that the modern, clean design was effective in engaging users and creating a positive first impression. It emphasizes the importance of visual appeal in digital applications, and the potential for good aesthetics to enhance user satisfaction.

Familiarity (Theme: Interaction with the app feels familiar) - This code represents the participants' sense of ease and familiarity when interacting with the application. The interpretation suggests that the design of the app successfully leverages existing user habits and digital literacy, which likely contributes to a smooth user experience. It underscores the value of designing interfaces that align with users' expectations and prior digital experiences.
**Complexity** (Theme: Add artifact page requires too many fields) - This code refers to the perceived burden of data entry due to the number of fields required when adding a new artifact. The interpretation is that the current data entry process may be unnecessarily complex, leading to user frustration. This could be a potential barrier to efficient use of the application and suggests the need for a more streamlined data entry process.

**Interactivity** (Theme: Loci Page Map does not provide tools to interact) - This code refers to the lack of interactive tools on the Loci Page Map. The interpretation suggests that users value interactive data visualization tools and that the lack of such tools on the Loci Page Map is a shortcoming. Enhancing map interactivity could improve the overall user experience.

**Navigation** (Theme: Artifact page is missing filtering options) - This code reflects participants' concerns about the lack of filtering options on the Artifact page. The interpretation indicates a need for more flexible and efficient ways to navigate artifact data. Providing advanced data navigation tools could enhance user satisfaction and the utility of the app.

By assigning these codes to the identified themes, the thematic analysis provides a structured, interpretive framework for understanding users' perceptions and experiences of the redesigned application.

### 4.3.6 Likert Scale Analysis

The following analysis focuses on assessing user feedback collected via a Likert scale on various aspects of the updated User Interface (UI) of the Archaeology application. Each question is graded on a scale of 1-5, where 1 represents a negative response and 5 represents a positive response. The goal, to measure users' first impressions, intuitiveness of the new interface, their experience retrieving artifact information, their rating of the field grouping on the add artifact page, and their overall evaluation of the app's functionality and user experience.
Q1: What was your initial impression of the updated UI when you first opened it?

User results: 4, 4, 5, 4, 3, 3, 4, 4, 3, 3.

The average (mean) response is approximately 3.64, suggesting that the initial impression of the UI is generally positive. The most common response (mode) was 4 and 3, indicating that a majority of the users found the updated UI good or neutral on their first encounter.

Q2: How intuitive was the new interface when using the figma LOCUS PAGE?

User results: 5, 5, 5, 4, 3, 4, 2, 4, 3, 4.

The mean response is approximately 4.09, which implies that the new interface was found to be quite intuitive by the users. The mode, being 4, reinforces this finding.

Q3: How was your experience retrieving Artifact Information from the ARTIFACT PAGE?

User results: 3, 5, 5, 4, 4, 3, 5, 4, 5, 3.

The mean response is approximately 4.18, showing that users had a good experience when retrieving artifact information. The mode for this question is 5, indicating that a significant number of users had an excellent experience with this feature.

Q4: How would you rate the field grouping on the ADD ARTIFACT page?

User results: 5, 4, 4, 3, 3, 2, 2, 4, 3, 3.

The mean response here is approximately 3.55, which suggests a slightly lower rating for the field grouping on the ADD ARTIFACT page. The mode is 4 and 3, which suggests that some users found the field grouping to be good while others found it to be merely satisfactory or neutral.
Q5: If you had to use this app regularly, how would you rate its overall functionality and user experience?

User results: 4, 5, 4, 4, 3, 4, 4, 3, 4, 4.

The mean response of approximately 4 indicates that users were quite positive about the overall functionality and user experience of the app. With a mode of 4, it can be concluded that most of the users found the overall user experience to be good. It's worth noting that while the mean and mode provide useful information, Likert scale data are ordinal and cannot conclusively demonstrate absolute differences between responses. Nevertheless, this analysis offers valuable insight into user perceptions of the app's UI.

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Figure 10. This sheet showcases the participant's responses on think aloud. Google Docs.
4.7 Summary of Results

Through the implemented data collection methods, valuable insights have been drawn. Direct observations offered a substantial understanding of on-site terminologies and procedures, such as the categorization of artifacts and the importance of stratigraphic layers. The study of existing documents suggested a substantial potential for digital transition, as much of the documentation is currently performed manually, lacking statistical data analysis and imposing repetitive tasks.

Interviews with the stakeholders reinforced the need for flexibility in the app design, support of different materials and improving data management with features like statistical exports and filtering capabilities. The necessity for an offline mode was also expressed, reflecting the real conditions of excavation sites.

The story mapping session produced a series of actionable items that could enhance the next release of the application. This method effectively broke down complex user activities into manageable steps and details, facilitating their transformation into development tasks. The brainstorming during the session led to new feature ideas that could optimize the user experience, such as adjustable UI per user type, on-site artifact addition, table result filtering, 3D view of the excavation, and statistical export features.

Think aloud brought to the surface useful results after analyzing two different types of information. Open-ended questions returned small paragraphs after each activity containing feedback on user experience which then categorized into five major themes. Five point likert scale rated application quality. Descriptive Statistics and data visualizations were exported providing insights to the user’s mind in a cheap way.

Overall, these results illuminate the specific needs of archaeologists using digital tools for their work. Some of the outcomes successfully triangulated as involved in multiple data sources. The insights gathered offer a roadmap for improving the application in ways that could genuinely benefit its users and facilitate more efficient and effective archaeological work.
CHAPTER 5: Discussion and future proofing
5.1 Gap questions

Navigating the complexities of the archaeological field during, a constellation of questions from the existing literature came into focus. These high-level inquiries served as critical markers, guiding the trajectory and depth of the research. Each step taken in this research reintroduced these questions, demanding novel solutions in real-time and encouraging a flexible approach towards problem-solving.

Undoubtedly, certain inquiries proved challenging to address effectively, mostly because they were affected by factors beyond the concern of the academic environment, incorporating broader socio-cultural or technological dimensions. Yet, these challenging questions have not been dismissed, rather, they have been used as an integral part of daily problem-solving.

Despite their complexity, these questions have been embraced as opportunities, serving as a driving force to think creatively and future-proof this research. They are approached abstractly, constantly pushing the boundaries of conventional thought, and demanding innovative solutions that could be relevant not only for the present study but also for future research in the field.

Q1: “Following the state of art, what specific needs, and pain points archaeologists continue to have when using digital tools for their work?”

Hardware and Software Reliability

It is important that any digital tool implemented for archaeological work is robust and reliable. From the hardware perspective, devices must withstand varying environmental conditions often encountered in the field such as temperature fluctuations, moisture, dust, and rugged usage. The battery life needs to be long enough to support a full day's work without requiring frequent recharging. In terms of software, speed and efficiency are crucial. Slow, laggy, or crashing applications can significantly slow down the recording process and lead to frustration among users. Therefore, designing and optimizing a software solution with a strong focus on performance and stability is essential.
User-friendly Environment:

The design of the application interface must be intuitive and closely align with the existing workflows of archaeologists. Archaeologists often have to manage a myriad of complex tasks, and a steep learning curve associated with a new digital tool can be a significant barrier to adoption. Therefore, the digital tool should be designed in such a way that it mirrors familiar processes and terminologies, thus reducing the cognitive load for the users and making the transition to the digital platform smoother.

Data Security and Backup:

In archaeological work, every bit of data is valuable, and loss of data can lead to significant setbacks. Digital tools must therefore incorporate robust data backup and recovery systems to prevent loss of data due to any unforeseen circumstances such as hardware failure, software glitches, or human error. Furthermore, given the sensitive nature of archaeological data, the platform must also ensure data security and privacy to protect it from unauthorized access.

Q1: Are there any standards for naming or codification used for creating these datasets?

Standards for naming or codification play a pivotal role in ensuring the consistency and interoperability of datasets across various systems and platforms.

Dublin Core Metadata

A common standard that has been leveraged in various fields, including archaeology, is the Dublin Core Metadata Initiative. The Dublin Core is a simple yet flexible standard for creating metadata for digital resources. It comprises a set of 15 base elements, such as title, creator, subject, description, and so on, which can be enriched with qualifiers for increased precision and granularity. Using such a standard can facilitate interoperability and sharing of datasets across different systems and platforms.

A research paper titled "Integrating Dublin Core Metadata for Cultural Heritage Collections Using Ontologies" explores this idea further. It delves into the use of ontologies for enhanced
semantic interoperability and harmonization of Dublin Core metadata in the context of cultural heritage collections.

**Team Documents**

In some instances, archaeological teams may also develop their own set of guidelines or standards for data entry and codification, which are documented and shared within the team. These documents serve as a reference point and aim to maintain consistency in data entry across different team members and over time. It can be as simple as a shared glossary of terms, or as complex as a detailed data entry manual, depending on the scale and complexity of the project.

**Q3: How can the app support collaboration among archaeologists, both within a team and across different archaeological projects?**

Supporting collaboration among archaeologists, both within a team and across different archaeological projects, is one of the key challenges the app aims to address. This can be achieved in several ways:

**Public Version of Artifact Data**

The app could offer a public version of artifact data which would be viewable by all team members and other stakeholders. This would allow everyone to stay updated with the latest findings and data updates, fostering a sense of collaboration and transparency. The public data should be presented in an easily readable format, with essential information about the artifact such as its description, location, and photos. This would also help in generating public interest and awareness about the project. [3]

**Project Web Sync and Distribution Among Users**

Another way to promote collaboration is by ensuring real-time synchronization of project data across all devices used by the team members. This would enable each member to have access to
the latest data at all times, regardless of their location. The app should also facilitate distribution of tasks among team members, with features like task assignment, progress tracking, and notification systems. This would streamline the work process, and ensure that everyone is aware of their roles and responsibilities.

**Cross-Project Collaboration**

To support collaboration across different archaeological projects, the app could have a feature that allows the sharing and comparison of data from different sites or projects. This could lead to new insights and conclusions, and promote a more holistic understanding of the archaeological landscape. Furthermore, it could foster a community of practice among archaeologists, where they can learn from each other’s experiences and findings. [25]

**Q4: How can the web app be effectively designed to handle archaeological data?**

Effective handling of archaeological data is a key aspect of designing a web app for use in the field. Here's how it can be achieved:

**User-Centric Design**

The design of the app should focus on creating UI-UX elements that are familiar to users. Using icons, menus, and other elements that are similar to what archaeologists already use in their day-to-day tasks can reduce the learning curve and facilitate adoption. Moreover, the design should be intuitive and simple, ensuring that users can navigate through the app and access the necessary information with ease.

**Incorporating Latest Industry Features**

The use of advanced features like AI tools can greatly enhance the app's data handling capabilities. For instance, AI could be used for tasks like automated classification of artifacts, predictive analytics for excavation planning, or image recognition for easier logging of finds. However, it's important to ensure that these features are implemented in a user-friendly manner and that they genuinely add value to the user experience.
Optimizing Development Priorities

Rather than trying to incorporate every possible feature, it's crucial to prioritize based on user needs and project resources. This means focusing on the most impactful features and improving them iteratively based on user feedback. Avoid investing resources into developing "loop hole" features that might seem fancy but don't actually contribute to the core functionality or usability of the app.

Data Security and Integrity

Since archaeological data is sensitive and valuable, the app must incorporate robust security measures to protect against data breaches. Furthermore, to prevent data loss, the app should have reliable backup and recovery mechanisms in place.

5.2 Features to include

Keeping the archaeological software abreast with the newest features and innovations is necessary. It makes the application stand out in front of competition and is functional for the proge users. As in any field heavily relying on technology, archaeological software also necessitates continuous updates and refinements to cater to changing requirements, to leverage new technologies, and to improve the overall user experience.

The research conducted during the course of this project has laid a sturdy foundation for the ongoing development of the software. It has identified specific targets that, if achieved, would greatly enhance the application's utility. Among these targets are:

5.2.1 Supporting different user types

The user base of the software spans from excavation coordinators to field student researchers, each with unique requirements and preferences. Tailoring the UI and the rules based on the user type could drastically improve the user experience. [22]

5.2.2 Digital 3D view of the excavation site and artifacts
This feature could revolutionize the way archaeologists interpret the excavation site and the artifacts. It could also facilitate collaboration among archaeologists and aid in data sharing.[30]

**5.2.3 Integration of Artificial Intelligence tools**

AI has tremendous potential in the field of archaeology, from predicting archaeological sites to analyzing artifacts and managing data. Harnessing AI could elevate the software's capabilities to a whole new level.

While achieving these targets would greatly enhance the software, it is equally important to remember that innovation is an ongoing process. Just as the present targets emerged from the latest technological advancements and research findings, future advancements will undoubtedly lead to new targets. Hence, the software needs to be flexible and adaptable, with an architecture that supports integration of future advancements. It should be continuously developed, evaluated, and updated based on user feedback, emerging technologies, and evolving needs in the field of archaeology.

Continuous development and innovation not only improve the software's functionality and usability, but also ensure its longevity and relevance in the rapidly evolving technological landscape. In this regard, the future proofing of the archaeological software is not just about adopting the latest technologies, but also about fostering a culture of innovation and adaptation that is responsive to the changing technological and archaeological landscapes.[28][18]

**5.4 Research to follow**

As we transition towards the conclusion of our discussion on the impending technical enhancements, it is crucial to mention that research is an iterative and ongoing process, and not always straightforward. This understanding is especially pertinent in the context of our study, where the realm of technology meets the dynamic world of archaeology.

The need to expand the investigative methods utilized in this research is critical. Continual communication with the archaeological practitioners using structured methods like focus groups and further document analysis ensures that our technological endeavors remain
synchronous with the evolving needs of the field. This form of continuous engagement enables to align design considerations more accurately with the practical realities of archaeological work.

Furthermore, the scope of the story mapping can be further adjusted to cover a broader range of user activities. The activity items in the backlog, generated from the initial story mapping, can have a deeper analysis to ensure that continually refining and understanding the design.

It is also worth exploring the potential of incorporating more Think Aloud sessions as a basic component of usability testing for future design iterations. These sessions are a cheap and valuable asset, enabling to glean additional insights into how users interact with updated versions of the design in real-world settings.

In essence, this research should not be seen as a finite project but rather as a foundational springboard for future explorations. Through sustained research efforts and ongoing engagement with the end-users, a future where the symbiosis of technology and archaeology is not just conceivable, but a reality.
CHAPTER 6: Conclusion

This research represents an in-depth exploration into the complexities of designing a web-based application within archaeological practice. Through a rigorous multi-method approach encompassing direct field observations, interviews, document analysis, and user story mapping and a think aloud we have gained significant insight into the nuanced requirements of archaeological professionals and the manner in which digital tools can enhance their practice.

This study emphasizes the criticality of user-centric design, efficient data management, and the integration of search, filtering, and visualization capabilities for enhancing the utility and user experience of digital archaeological tools. It has been ascertained that consistent design patterns and adherence to user-centered design principles significantly improve the efficacy of digital tools, thereby facilitating archaeological work.

Simultaneously, this investigation revealed the significant challenge of handling expansive volumes of archaeological data and posited the potential of advanced technologies, including 3D visualization and AI tools, in addressing this issue. Additionally, a recurring theme throughout the research was the importance of fostering effective collaboration and exchange of information among archaeological professionals, underscoring the role digital tools can play in this endeavor.

Regarding the applied methodology, the approach of combining different methods offered a comprehensive and multi-dimensional understanding of the context, the actors and user engagement with digital tools. The complementary use of these diverse methods established a robust framework for data triangulation, thus enhancing the validity and reliability of the study's findings.

This research successfully addresses a notable gap in the existing body of knowledge regarding the use of digital tools in the realm of archaeology. However, it simultaneously uncovers further areas of exploration and potential for future investigation. Given the dynamic nature of both archaeology and digital technologies, the opportunities for continued research within this sphere are vast.
In conclusion, the findings of this study contribute significantly to the body of knowledge regarding the development of functional, user-friendly and overall tailored digital tools for the field of archaeology. It demonstrates the potential of integrating the past with future-facing technologies, and how this synergy can herald a new era in archaeological research and practice.

This study not only contributes to our understanding of the present intersection between archaeology and technology but also provides a foundation for future explorations.
References


Web sources

[S1] Dublin Core Metadata Element Set Link

[S2] Archaeological Data Service (ADS) Guides to Good Practice Link

[S3] Nielsen Norman Group Link