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Database for the utilization of diagnostic techniques in the conservation of cultural heritage

Mavrommati Maria[1*], Parissis Stamatis[2], Spathis Panagiotis[3], Koronas Dimitrios[4]
[1] PhD Candidate, Teacher S.G, Department of Chemistry, Aristotle University of Thessaloniki, Greece
[2] IT, Information Center and Library, University of Thessaly, Greece
[3] Emeritus Professor, Department of Chemistry, Aristotle University of Thessaloniki, Greece
[4] PhD Candidate, Private Researcher, School of Mechanical Engineering, Aristotle University of Thessaloniki, Greece

Abstract
This article records the stages if the implementation of a database (DB), whose main purpose is the gathering of analytic and diagnostic techniques in the field of cultural heritage conservation, as well as the recording of relevant equipment of the research laboratories based in Greece. In particular, the database includes data concerning the following: a) which technique or method is used by each laboratory and to which materials it is applied, b) who is in charge of each laboratory and c) in what way can they utilize these tools and techniques to carry out research. At the same time, the aforementioned techniques and methods are described in the DB for anyone looking for information on these subjects and in particular for the students studying Antiquities and works of art conservation at the vocational high schools in Greece. The main objective of this DB is to be a modern tool for scientists, researchers and students (University and high school) in the field of cultural heritage conservation.

Keywords: Diagnostic techniques, preservation of antiquities, research centers, educational tool

Introduction

Article 13 of the Code of Ethics of the European Confederation of Conservation-Restorers Organizations (E.C.C.O.), states "Where necessary or appropriate, the conservator-restorer cooperates with other professionals and participates with them in full information exchange" (E.C.C.O., 2003). This article, highlights the need for interdisciplinary collaboration as scientists from different fields (physicists, chemists, engineers, conservators, architects, archaeologists, etc.) often work better together to tackle complex challenges, share information, as well as ensure quality and the safer preservation of cultural heritage.
The field of artwork conservation research, includes a wide range of analytical and diagnostic techniques that are constantly involving, based on new data in the related sciences and technological developments. Their use is one of the first stages of a conservator's work on monuments and heirlooms, as it is deemed necessary to determine their structure, technology and composition, study their structure, control their deterioration and ascertain the results of past interventions.
The investigation of the structure and technology of the materials provides critical data for the proper planning of the conservation treatments, for the correct selection of methods and means of treatment of each problem and for the successful and safe handling of the materials to be selected, without causing further deterioration. The process of finding these techniques and the related tools to implement them is often hindered by the inability to locate specialized centers and related available equipment.
In recent years, developments in digital technologies have offered significant opportunities in the field of cultural heritage. Based on this, the systematic gathering of these data in digital form combined with a sophisticated search engine is now feasible and can fill the gap encountered not only by the new researcher, teacher and student, but also by the most experienced researcher in the field of cultural heritage conservation.
This article presents the methodology, the design and the implementation of a digital DB whose main purpose is the gathering of analysis and diagnosis techniques in the field of cultural heritage conservation, as well as the recording of the relevant equipment of the research laboratories based in Greece. In particular, the database includes data concerning the techniques or methods of each laboratory, the equipment they have and the materials they are applied to, as well as the details of the laboratory managers. At the same time, the aforementioned techniques and methods are described in the database for anyone interested in obtaining basic information on these subjects, and in particular for students studying the specialty of Conservation of Antiquities and Works of Art at Vocational High Schools in Greece.
The DB can contribute to more effective communication and cooperation between researchers, students (university and high school) etc. that focus on the preservation of cultural heritage, to upgrade the level of communication of the scientific and educational community, as well as to contribute to the extroversion of laboratories towards citizens and private institutions. The DB is mainly addressed to the research field of culture and in particular to archeometric research and the conservation of antiquities and works of art, with the prospect of approaching other scientific fields in the future.
In addition, the DB can be a basic learning tool for students studying the specialty of Conservation of Antiquities and Works of Art at the Vocational High Schools of Greece, as it will provide them with the possibility with a simple and quick search to obtain information about each technique and the materials to which it is applied (stone, glass, metal, icon, tarpaulin, paper, etc.).

The data analysis was carried out in the context of a doctoral thesis on the topic "Utilization of diagnostic analysis techniques in the conservation of archaeological finds", which is carried out at the "Laboratory of Chemical and Environmental Technology" of the Chemistry department of the Aristotle University of Thessaloniki (Spathis, Mavrommati *et al* 2021, Euromed, 2021).

In the text that follows, the most important databases that support cultural heritage conservation issues are initially studied. Next, the methodology and the design and implementation of the BD are presented, with reference to the objective, the benefits and the difficulties that may arise during its use. The article concludes with the conclusions, limitations and suggestions for further development of the full base.

Brief background and literature review

In recent years, methods and diagnostic analysis techniques have been used extensively in the science of antiquities conservation. Data collected from the results of diagnostic techniques are often stored in databases, repositories or digital platforms, thus allowing easy access, facilitating knowledge sharing and contributing to future research. There is a rich literature on the world wide web from international bodies (UNESCO, ICOMOS, ICCROM, ICOM, WMF etc.) that focus on the preservation of cultural heritage and have implemented relevant digital tools. A case in point is the Arches project (https://www.archesproject.org/), which is a collaborative effort to create an open-source geospatial information system for cultural heritage inventory and management. The Arches project was developed by the Getty Conservation Institute and the World Monuments Fund and brings together heritage professionals and software developers from around the world who are interested in sharing their skills and expertise in this initiative.

Several glossaries related to cultural heritage are also available online. A typical example is the illustrated glossary EwaGlos (Weyer *et al*. 2015) [15], which is offered by the open archive of the International Council on Monuments and Sites (http://openarchive.icomos.org/). It has been developed in eleven languages, highlighting the critical role that professionally developed multilingual glossaries play in international conservation campaigns. EwaGlos emphasizes the importance of a common language in artwork conservation and the role that international cooperation plays in creating a common terminology. The core glossary includes approximately 200 definitions of terms frequently used in specifications in the field of mural and architectural surface conservation-restoration.

The Getty Research Institute as part of the dictionaries it has created for various sciences implemented the Art & Architecture Thesaurus ® Online, a glossary containing general terms in various languages, sources and scope notes for agents, types of work, roles, materials, styles, cultures and techniques related to art, architecture and cultural heritage in general (https://www.getty.edu/research/tools/vocabularies/aat/index.html).

Similarly, the Center de Recherche et de Restauration des Musées de France took the initiative to create a multilingual glossary which will include technical-scientific terminology on the conservation and restoration of cultural heritage (CRISTAL 1999-2000). The Associazione Giovanni Secco Suardo (A.G.S.S) has contributed significantly to this undertaking, writing the first specialized Italian dictionary of terminology for artwork conservation and restoration of frescoes entitled “Painting Murale Proposta per un glossario” [Wall painting. Proposal for a dictionary] (https://cbccoop.it). Additionally, A.GSS promotes projects and initiatives such as conferences and seminars, the creation of archives and databases, the promotion of cultural and scientific exchanges in Italy and abroad, participation in projects carried out in developing countries, as well as publishing activities. This has been achieved through collective efforts involving both the public sector, such as ministries, universities, museums, recognized educational institutions, and the private sector, which includes institutions, museums, etc. and other bodies active in the field of cultural heritage conservation (https://www.associazionegiovanniseccosuardo.it).

In the Greek region, the Institute of Electronic Structure & Lasers and the Institute of Informatics of the Technology and Research Foundation (ITE) have implemented the online knowledge platform "Polygnosis" which can be used to improve access to information on the latest laser applications and methods for the conservation, analysis and diagnosis of cultural heritage objects. It aims to bridge the gap between conservation and laser science and mainly aims in making new knowledge about laser technologies more accessible and understandable to heritage professionals and scientists by disseminating laser know-how keys and related innovations, as well as by exchanging examples of applied laser methodologies on objects and monuments. Polygnosis provides a basic introduction, best practice examples, and a semantically linked structured vocabulary related to visual techniques and laser (ISL & CCI, 2015) [10].

Also, the Department of Conservation of Antiquities and Works of Art of the University of Western Attica implemented a specialized documentation system named "Ariadne", in order to manage and document objects from its laboratories. In addition, Ariadne also focuses on educational needs by providing valuable support to students to understand and engage with the documentation process, thus fostering a deeper understanding of the subject (Chatzidakis, 2008)[3].

Difficulty accessing information about diagnostic techniques

All of the above modern tools can help the work of those active in the field of cultural heritage conservation. But despite the fact that in Greece there are a number of specialized laboratories operating in Universities, Institutes, Research Centers, etc. there is no single database or web portal to present researchers and the public with their overall focus and capabilities. Today, a researcher, student or student interested in the diagnostic techniques and conservation of antiquities, has quite a difficult time in locating the specialized laboratories and their available equipment, which complicates the research as well as the educational process. These difficulties may lead to changes in decision-making regarding the appropriateness of the technique to be applied and as a result delays in the implementation of a project. Even when the laboratory is located, sometimes the specific techniques cannot be used in the time frame of the research implementation, either

because the equipment has not been maintained, or because it is broken, or because there is no suitable staff to cope with what is requested.

In order to deal with the gap that arises in the direction of solving the above-mentioned problems, which even the most experienced researcher in the conservation of cultural heritage encounters, an attempt was made to implement a BD, in which all the available data of the specialized laboratories will be collected, enabling anyone engaged in research in the field of cultural heritage conservation to start their work efficiently and without unnecessary expenditure of time.

Design and implementation of the DB for the utilization of diagnostic techniques in the field of cultural heritage conservation

The identification of the gap that the DB is called to cover was followed by a series of informal discussions by the researchers with pupils, students, vocational education artwork conservation teachers, researchers and conservation experts, in order to confirm the need for its implementation. Overall, a positive attitude was observed, reinforcing the initial enthusiasm of the researchers for its implementation. In addition, in these discussions the benefits were recorded and the participants were asked for their opinion regarding its content and its operation. All of the respondents stated that they would like to know the following for each specialized laboratory: a) the diagnostic techniques and methods applied (destructive and non-destructive), b) the technical equipment in operation and its availability, c) the person in charge of each analytic technique, d) the possible specialization of each laboratory, e) photos of the equipment, f) the possibility of borrowing, g) the geographical location

In addition, students studying Conservation of Antiquities and Works of Art in Greek vocational highschools, stated that it would be useful to have basic information about diagnostic techniques.

Finally, in the next step, the creation of the DB in a foreign language is sought, in order to expand beyond the borders.

Objectives, benefits, barriers and difficulties of BD in the research and education community

The objectives set for the creation of the database were:

- The use of diagnostic analysis techniques.
- The interdisciplinary approach of the DB offers opportunities to solve research issues.
- The organization and classification of data should be done in such a way that the DB is friendly for easy and immediate use.
- The navigation should be designed in such a way that it addresses any user of the scientific and educational community, as well as the general public.
- To be a valuable educational tool in the hands of teachers and especially students of secondary education, and specifically in the department of antiquities and works of art conservation, in the field of applied arts, in vocational high schools.
- To link research-innovation with entrepreneurship and the extroversion of businesses and researchers organizations.
- To contribute to the communication of science and its use by the educational community and the public. To contribute to the research developments of conservation grade materials

Among the benefits recorded, the following are highlighted:

The benefits recorded are summarized in principle in that a database is created for diagnostic techniques in cultural heritage conservation through a central repository that offers the possibility of effective data management, promotes knowledge exchange and collaboration, supports research and education, gives wide access and create international impact. Particularly:

Central Repository: BD provides a central repository for storing and organizing information about diagnostic techniques. It enables systematic storage of data, making it easily accessible to researchers, conservators, students and pupils. It gathers and consolidates all the data that exists scattered in individual sources in a single and reliable database controlled by the AUTH scientific community.

Efficient data management: DB enables efficient management of diagnostic results. It introduces structured data integration, categorization and organization based on specific parameters such as hardware, technique or geographic location saving users valuable time.

Exchange of knowledge and cooperation: The DB facilitates the exchange of information and knowledge between professionals in the field of cultural heritage conservation. Researchers, conservators and students can contribute their findings, experiences and studies to the database, promoting collaboration, sharing best practices and disseminating new data.

Research and Education Support: Researchers can use the database to explore existing diagnostic techniques, analyze trends, and identify gaps in knowledge. Students can access the DB which can act as a knowledge bank to collect information on different techniques, review case studies and enrich their knowledge of conservation practices. This contributes to the advancement of research and the enhancement of educational curricula.

Accessibility and global reach: Researchers, conservators and students from different parts of the world can access the DB, overcoming geographical barriers and thus encouraging the promotion of international cooperation in the field of cultural heritage conservation.

Barriers and difficulties identified:

The process of digitization and online publication raises a number of issues, such as the issue of intellectual property, which is subject to intense and ongoing debate. [15][16].

Scientists may face difficulties in using, adapting and exploiting DB as a new tool. That is why it would be appropriate to guide the interested parties through e.g., of online journals or through integration on the DB home page a video instruction manual.

Methodology

The first work on the creation of the DB began in late 2017, but a series of unforeseen circumstances that arose and then the pandemic resulted in the design team relaunching in 2021. At an initial level, discussions were held with industry professionals and everyone agreed on the need to create such a DB. The procedures carried out for the collection of the data and the creation of the BD were the following:

The primary objective was to define the functional requirements. A focus was then placed on the design and

development of the DB to ensure that it would be practical, feasible and flexible.

This was followed by the recording of the needs that classify the data for the creation of the database, which are as follows:

- the diagnostic techniques and methods applied (destructive and non-destructive),
- research centers, university institutions
- the technical equipment, the person in charge of each technical analysis, any specialization of each laboratory,
- contact info,
- equipment photos,
- case studies,
- terms of use,
- useful links,
- database information

Afterwards, the registration of the research organizations and agencies in the Greek region was carried out. Thirty-two (32) emails were sent for the collection of laboratory equipment. Data were collected from thirty-one (31) centers-laboratories for a total of thirty two (32). Most of them (17) sent their data immediately. Several of the managers of the agencies accepted this proposal with great enthusiasm. If there were any delays, a phone call was made to the specific research centers-laboratories. Some of them had posted on their official websites the data that was necessary to be collected and the reference was made to them. However, it is worth noting that only one research center refused to respond on the grounds that they would not want their equipment disclosed.

Data entry by category was done in a Microsoft Excel spreadsheet program. The organization of the data was done in a way to make it easier to locate and use it.

Completing the above stages, the first phase of construction of the DB began, implementing a part of the basic design with prospects for expansion by the future management team from AUTH.

Development of the database

The design and development of the Content Management Systems (CMS) was carried out with open software tools.

The implementation of the websites and their management was done with the help of Visual Studio 2022 Community Edition in ASP.NET and C# (C Sharp). The technology on which it was based was the one provided by SQL Server 2022 Developer Edition (full-featured free edition), while the design and management was done with the help of SQL Server Management Studio (SSMS), taking into account the use of international standards both in data storage, as well as in the use of culture data (CIDOC/ICOM-https://cidoc.mini.icom.museum), laboratory measurement quality (ISO 17025) and data management quality (ISO 9000). The BD has the possibility of automatic updating by the agency itself or the laboratory to which the information is referred, or automated updating by installing mediators connecting the agencies to each other.

The DB, as well as its management environment, has been designed and carried out by a member of the implementation team and will be hosted by AUTH servers in collaboration with the Chemistry department, which is defined as the Implementing Agency (I.A) and as the Management Agency (M.A) of the proposed DB.

User categories It includes 5 different categories of users (fig. 1)

System Administrator (Administrator)

Grants Platform Administrator (Admin) rights, modifies the account status of users (active, inactive, visitors, etc.), permanently deletes users, performs database maintenance which includes: backup copies, restore copies, rebuild base and tables, delete base and tables and import / export (Import/Export) base and tables. Finally, he can also edit the entries - update the entries.

Platform Administrator (Admin)

Gives administrator rights platform (Super User and User), modifies users' account status as active and paused, is allowed to make comments per user. It also performs temporary deletion of registration and participates in registrations - updates of registrations.

Super User

Performs the temporary deletion of an entry and participates in the entries - updates of the entries. Makes prints and special reports from the DB.

User

Enters and modifies the content of the database, as well as manages searches with their references.

Guest User

Does not need authentication to enter the platform and can view and search institutions and equipment.

Basic DB functions-stages that have been implemented

1. It consists of seven tables that manage both user data and record data related to equipment owned by institutions and organizations (Figure 2).
2. The home page of the platform provides basic information about the DB and the user can choose the next steps, such as browsing, searching for equipment, etc. (Figure 3).
3. It enables the website visitor to search for laboratory equipment as well as to see where it belongs (fig. 4).
4. Possibility for the user to enter the platform and, depending on his grade, to go to the actions he is allowed. As we can see, if he is a new user he can register and wait for his activation by the administrators and he is also given the possibility to recover his password in case of loss with a fully automated system at an electronic address (Figs. 5, 6).
5. Ready-made options are offered in drop-down lists, which, if they do not contain the object to be recorded, are immediately updated by the user. On the side there is a presentation of all records with the possibility of selective search (Fig. 7).
6. The user, depending on his level, from the specific screen manages individually or en masse the reports - prints resulting from the DB data (Figures 8-9).
7. A print preview is presented which resulted from a search in the context of the equipment, the “therm” key, with the result that both on the previous screen and here the platform produces the results to be printed or saved in a pdf document (Figure 9).
8. It configures users according to the needs they will cover (Figure 10).

Administrator controlled DB tasks (Figure 11)

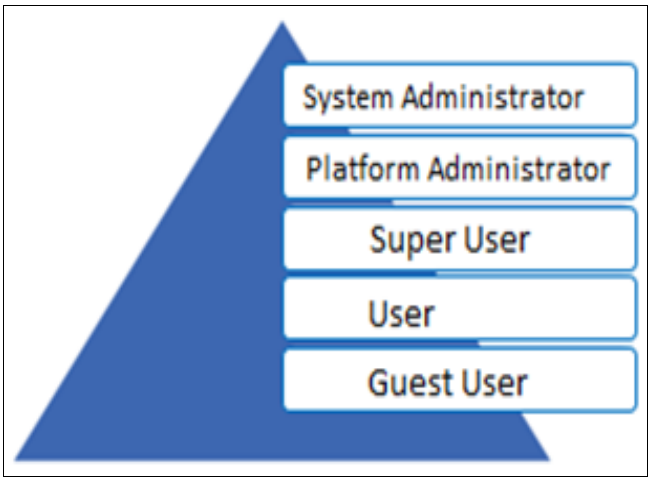

Fig 1: Types of users

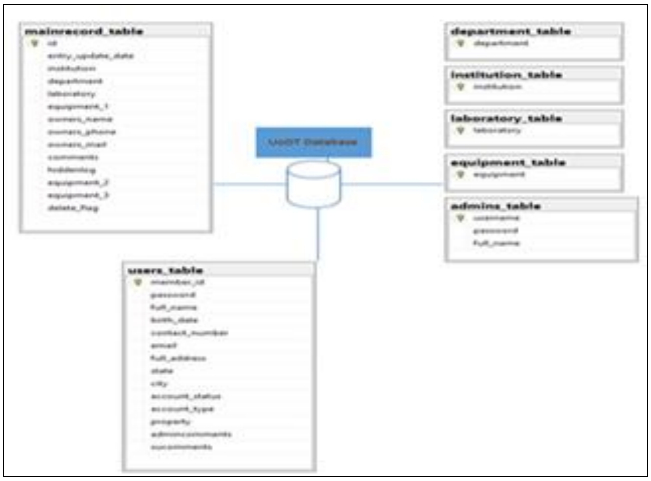

Fig 2: Planning DB

Fig 3: Home Page

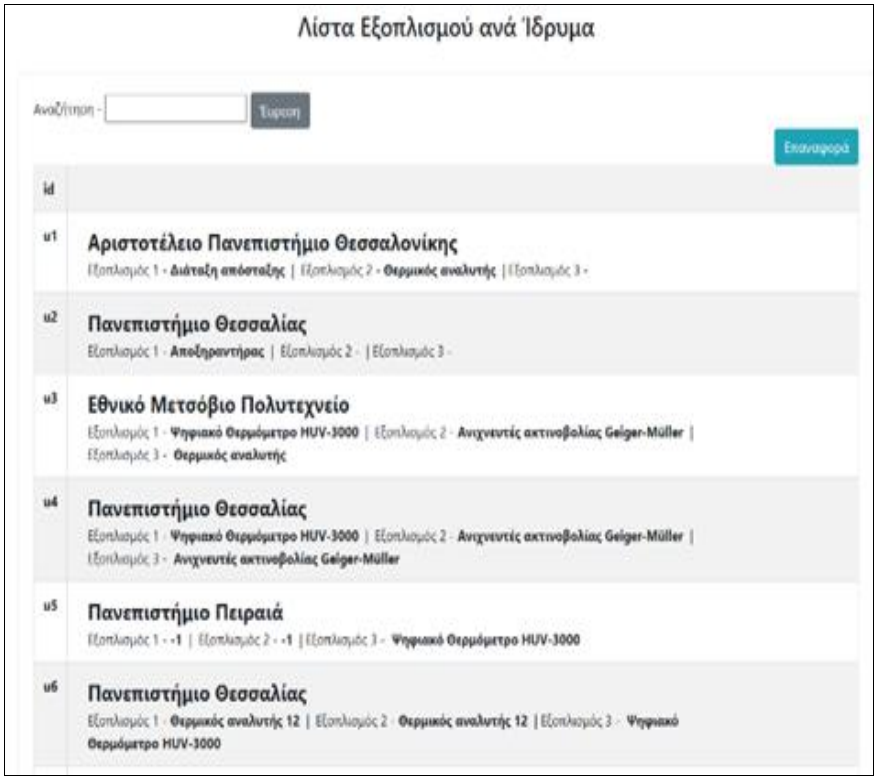

Fig 4: Visitor User search page

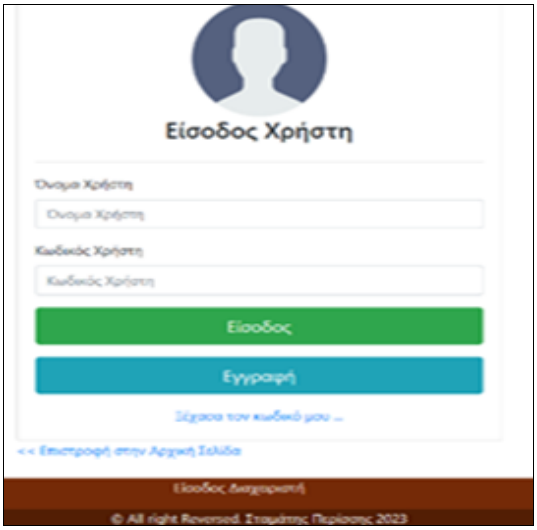

Fig 5: User Login

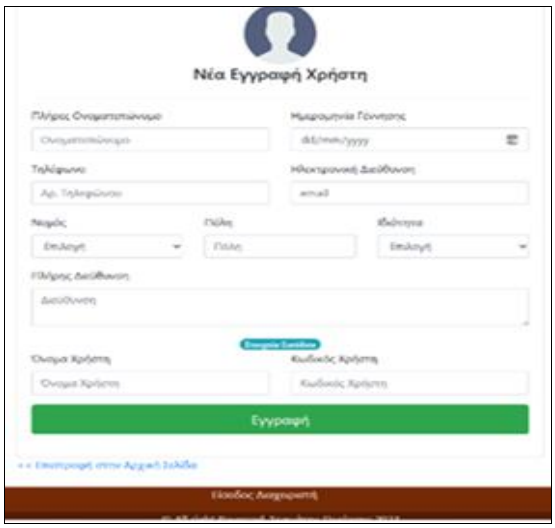

Fig 6: New User Registration

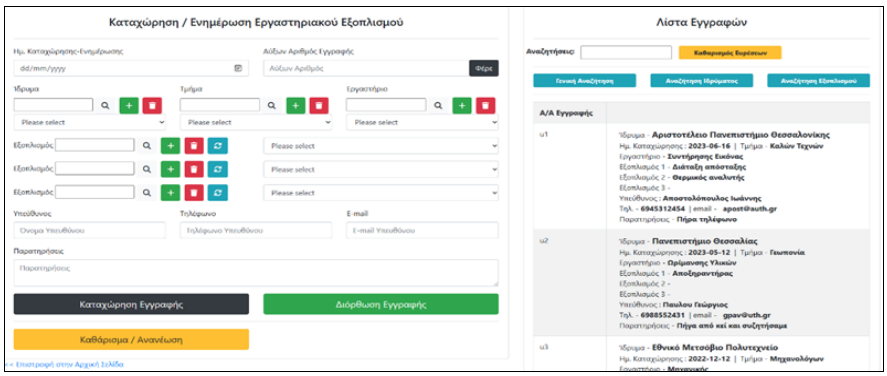

Fig 7: Entering User Data

Fig 8: Reference to print

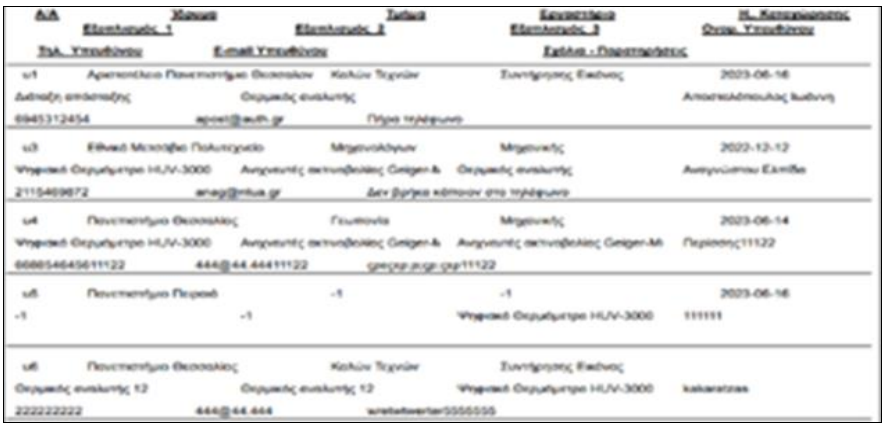

Fig 9: Image Reports - Printouts

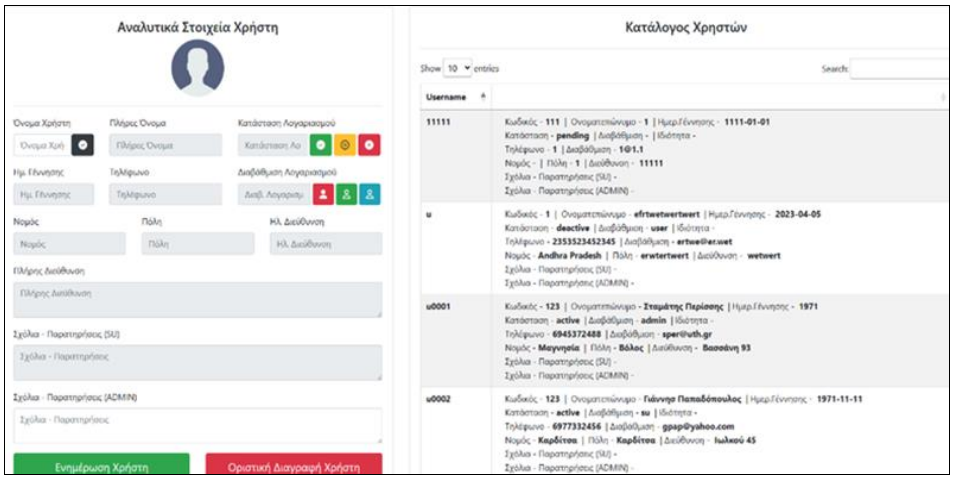

Fig 10: Administrator – Users

Fig 11: Manager - Database

conclusions - discussion

The article focused on the creation of a DB for the optimal utilization of diagnostic techniques by the research and educational community. It was established that there are laboratories with specialized human resources and good logistical infrastructure, which are not utilized to a large extent precisely because of the relative lack of information (https://www.dianeosis.org/research/research_policy).

With this DB, users are provided with a helpful tool which enables them to directly search the research centers, the methods they follow, the diagnostic techniques they apply, the equipment that is in use or available for loan, the specialization of the material, the geographical area, while corresponding information is provided for each technique *et al*., making it a truly useful tool for conservators, researchers, educators, students and any scientist active in the field of culture and the sciences, with the expectation that it will expand into more areas of research.

The innovation (Kalogirou G., Tsakanikas A., *et al*. 2021) [21] of the specific DB lies on the one hand in the services it can offer in a direct and functional way, on the other hand depending on the equipment and their needs, the agencies will be able to borrow instruments both in the short term and in the long term, in order to create new collaborations nationally as well as internationally. In this context, school conservation laboratories, but also more broadly all secondary education science laboratories could borrow equipment thus enriching the educational process. Or even, to accept donations from these centers and thus create wider collaborations. In this way, the research organizations and institutions will be able to inform about their activity and attract interested people from Greece and abroad, resulting in multiplying their collaborations.

The contribution of the specific base, it is clear that it will cover the gap that exists in the systematization of information and can be an important tool among researchers, teachers, students and everyone involved in the field of cultural heritage conservation and in addition to inform the public for the possibilities provided by research centers and organizations. However, it can also be used by private bodies that wish to carry out analyzes with a primary reference to culture (e.g., private collections, folklore museums, etc.) and with the prospect of approaching other scientific disciplines in the future.

In other words, it is a database that can be used both by the educational community and the wider public through the search for diagnostic centers and techniques, thus contributing to the communication of science and wider information. But above all it is an essential useful learning and information tool for young researchers, students and students oriented towards cultural heritage conservation.

In conclusion, the DB can make a key contribution to the functional utilization of ICT, to the organizational upgrading of services by research centers, institutions, etc. to the utilization of diagnostic methods by the entire research community, to the exchange of knowledge and information, to the communication of science with the wider public, in the extroversion of the centers and institutes, as well as in the development and promotion of the conservation of antiquities and works of art and other scientific disciplines.

The beginning has been made and there is a feeling of optimism for the full development of the platform under the expertise and guidance of the renowned scientists of AUTH, a distinguished university of the country. In addition, there is optimism that the scientific community will welcome it, support it and make use of it.

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