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Editorial message

Dear Colleagues,

JIIM is an international, multidisciplinary, blind peer-reviewed journal that publishes research efforts on all aspects and issues regarding Information Science and Integrated Information Management. The current issue publishes research articles about archives and records management in the machine learning technologies context, photos as tools to enhance the museum experience and infrastructure for managing institutional research archives.

The first paper explores the goal and potential of integrating machine learning technologies into archives and records management practices. Placing the subject classification of records at the center of the discussion, this paper presents a research hypothesis. It highlights the necessity of deepening the standardisation of government actions record management processes. Thus, readers have a deeper understanding of the transformative role that machine learning technologies can play in archives and records management, future practices and decision-making in the field.

The second paper studies the effect of photos on cultural technologies. Researchers used ancient museum objects with contemporary photos, showing people performing similar activities in antiquity and today. Qualitative data from interviews were collected and analysed to study the participant's reflection processes when they saw the images of ancient objects and contemporary photos. Photos can function as interpretation aids and also allow participants to make multiple connections between past and present, across societies and cultures, between current and prior knowledge, and permit connections to personal experience, leading to the conclusion that critical constructivist approaches take place when people are presented with the two images and meaning-making processes.

The last paper presents the adaptation of VIVO by the University of West Attica. Researchers have merged the existing systems and harvested research-related information from different sources on the web to create an ontology-based system for documenting the undertaken research within an institution. This solution offers the possibility for the personalisation of the ontology, thus making it possible to customise the repository to fit an institution's needs, and the web interface presents the perceived significant components for the University, as well as the information visualisation.

We welcome special Issues proposals that should be emailed to the Assistant Editor-in-chief (dkouis@uniwa.gr). Finally, we expect your contribution and active support with remarks and points of improvement.

Associate Professor - Assistant Editor-in-chief

Dimitrios Kouis

Department of Archival, Library and Information Studies University of West

Attica Agiou Spyridonos Str., 12243 Aegaleo, Athens, Greece

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Archives and records management in machine learning technologies context: a research hypothesis on university records

Ioannis Triantafyllou[1], **Christos Chrysanthopoulos**[2], **Yannis Stoyannidis**[1], **Anastasios Tsolakidis**[3]
[1]Department of Archival, Library & Information Studies, University of West Attica, Athens
[2]Department of History & Archaeology, University of Patras and Department of Archival, Library & Information Studies, University of West Attica
[3]Department of Informatics and Computer Engineering, University of West Attica, Athens

triantafi@uniwa.gr [**ORCID**: 0000-0001-5273-0855], cchrysan@eie.gr [**ORCID**: 0000-0001-9900-1342], ystoyannidis@uniwa.gr [**ORCID**: 0000-0001-9551-8360], atsolakid@uniwa.gr [**ORCID**: 0000-0001-7364-4542]

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Abstract:

Purpose *- This paper explores the goal and potential of integrating machine learning technologies into archives and records management practices. As the volume and complexity of digital records continue to grow, traditional methods of organising, classifying, and managing records face new challenges. Machine learning technologies offer opportunities to revolutionise how records are maintained, accessed, and used.*

Design/methodology/approach *- The relationship between records and archive management and machine learning practices is presented through the literature. This paper proposes a case study implementation of machine learning practices for the subject classification of records at the University of West Attica.*

Findings *- This paper presents a research hypothesis placing the subject classification of records at the center of the discussion. It highlights the necessity of deepening the standardisation of government actions record management processes.*

Originality/value *- By exploring this topic, the paper seeks to contribute to a deeper understanding of the transformative role that machine learning technologies can play in archives and records management and to inform future practices and decision-making in the field. It is also the first theoretical part of an ongoing research project on the subject classification of the University of West Attica records.*

Index Terms — Archives and records management, Machine learning, Computational archival science, University archives, Subject classification

I. Introduction

Records and archives management classification, as a method of identifying and organising the records generated or received throughout business, is advised by archival theory to be based on an examination of the functions and activities of the records creators and reflect them. Methodologically, at the heart of archival theories and practices is the provenance of the records, thus placing it at the center of the archival description. **[1]** According to this theory, the relevance of records is greatly influenced by the context in which they were created, and the organisation and description of these items should be closely tied to their original role. **[2]** The principle of provenance, when applied to appraisal, encourages the use of an organisational method, a "top-down" approach, which has proven to be unsatisfactory because it leaves out the "powerless transactions," which might shed light on the larger social context, from the permanent documentation of society. **[3]** Traditionally the concept of provenance is intimately connected to the concept of original order. In this context, the subject classification of records is subordinate and interests archivists only if it is closely related to a function of the creator. Nowadays, born-digital records have created new needs in recordkeeping and archive management.

Duranti notes that there is essentially no difference between a traditional and a born-digital record because the elements that must be explicit in an electronic record are implicit in any analog/traditional record. The born-digital record has a structure with "date (time and place of creation, transmission, and receipt), an indication of persons (author, addressee, originator, writer, and creator), an indication of action or matter (title or subject), classification code, and any other element required by the creator's procedures or juridical system" **[4].** Although this condition may not

differentiate the traditional from the electronic record, it may create new processes in record management. What role can machine learning and artificial intelligence play in archives and records management?

This paper explores the potential benefits, challenges, and implications of integrating machine learning technologies into university archives and record management. By investigating the research hypothesis, we aim to explore how these technologies can improve the efficiency, accuracy, and accessibility of archival practices, ultimately benefiting academic and other institutions.

II. Machine Learning and Archives

Machine learning [ML] has the potential to significantly impact record management practices, offering new opportunities for efficiency, automation, and enhanced decision-making. Below we present some ways in which machine-learning systems can intersect with record management:

- Automated Classification and Metadata Extraction: ML algorithms can be trained to automatically classify records based on their content or extract relevant metadata from documents. This automation reduces the manual effort required for record classification and metadata entry, saving time and cost. ML models can learn from existing labelled data or use unsupervised learning techniques to identify patterns and make accurate predictions about record classifications. **[5]**
- Intelligent Search and Retrieval: ML algorithms can enhance search and retrieval capabilities within record management systems. By analysing user behavior, query patterns, and contextual information, machine learning models can provide personalised and relevant search results, improving the user experience and increasing the efficiency of information retrieval. Natural language processing techniques can also be employed to understand and interpret user queries, allowing for more accurate and contextual search results. **[6]**
- Record Deduplication and Data Cleansing: ML algorithms can assist in identifying and removing duplicate or redundant records within a collection. By comparing the content, metadata, or other characteristics of records, machine learning models can automatically flag potential duplicates, enabling efficient data cleansing and improving data quality. The above helps reduce storage costs, ensure data integrity, and streamline record management processes. **[7]**
- Predictive Analytics and Decision Support: ML algorithms can analyse historical record data and identify patterns or trends, enabling predictive analytics and decision support capabilities. By leveraging machine learning models, organisations can gain insights into records, such as identifying potential risks, predicting record retention needs, or identifying records requiring special attention or disposition. These insights can support more informed decision-making and aid in developing proactive record management strategies. **[8]**
- Security and Risk Management: ML techniques can be utilised to identify potential security risks or anomalies within record management systems. Machine learning models can analyse user access patterns, identify unusual behaviors, and detect potential security breaches or data leaks. By leveraging these models, organisations can enhance their security measures, identify and mitigate risks, and ensure compliance with data protection regulations. **[9]**

It is important to note that while ML offers significant potential for improving record management practices, careful consideration must be given to data privacy, ethics, and the transparency of algorithms. Organisations should ensure proper training and validation of machine learning models and regular monitoring and evaluation to maintain their accuracy and effectiveness. Additionally, human expertise and judgment remain essential in implementing and overseeing machine learning applications within record management processes.

III. Computational Archival Science and Machine Learning

Computational archival science is an emerging field that explores the intersection of archival science and computational methods, including machine learning. **[10]** It leverages computational techniques and technologies to analyse, process, and manage large-scale archival collections, enabling new insights and capabilities for archival practice. As a subfield of computational methods, machine learning is crucial in advancing computational archival science. Expect automated processing, classification, and analysis of the archival collection; machine learning algorithms, such as optical character recognition (OCR) and image recognition models, can be applied to archival documents. OCR can convert scanned or handwritten text into machine-readable formats, facilitating full-text search and analysis. Image recognition models can identify and classify visual elements, such as photographs, maps, or diagrams, aiding the organisation and contextualisation of archival materials. **[11]**

Machine learning techniques can be utilised to mine and extract valuable information from archival collections. Machine learning models can identify significant entities, events, or subjects by analysing patterns, relationships, and trends within the data. This information extraction process can assist in creating semantic connections and generating metadata, enabling enhanced search, retrieval, and analysis of archival materials. By employing techniques such as clustering, dimensionality reduction, or topic modeling, machine learning models can reveal hidden patterns or

relationships within the data. **[12]** Visualisation tools can then present these findings intuitively and interactively, enabling users to explore archival collections from various perspectives. Algorithms can be trained to identify potential physical or digital records risks, such as deterioration, mold, or data corruption. By leveraging machine learning models, archivists can proactively monitor and address preservation needs, ensuring the longevity and integrity of archival materials. **[13]** Additionally, interdisciplinary collaboration between archival professionals, data scientists, and domain experts is crucial to ensure the ethical and responsible application of machine learning techniques in archival practice. Along these lines have been developed several software tools for archival practices **[Table 1.]**.

Software	Creator	Description
ePADD	Stanford University Libraries	Free and open-source software developed that supports the appraisal, processing, preservation, discovery, and delivery of historical email archives.
BitCurator NLP	BitCurator Consortium	Software for collecting institutions to extract, analyse, and produce reports on features of interest in text extracted from born-digital materials contained in collections.
ArchExtract	Bancroft Library (University of California Berkeley)	A web application that enables archivists and researchers to perform topic modeling, keyword, and named entity extraction on a text collection.

Table 1. Representative software for the management of archival material using machine learning

IV. Machine Learning in a University Record Management System: an Experimental Question

University archives and record management are vital in preserving and managing universities' historical, administrative, and cultural records. The connection between the past and the present is made possible by university archives, which also act as a lighthouse for highlighting the contributions made by educational institutions to society. **[14]** Record management in universities involves systematically controlling and coordinating records throughout their lifecycle, from creation to final disposition. Today at the University of West Attica, as in all universities in Greece, there are different software/services for managing bureaucracy and producing records. The Greek government started the Diavgeia project (Transparency Program Initiative) in 2010, intending to restore faith in the democratic system and enable online insights into government spending. Diavgeia has been pivotal in promoting transparency and accountability in the Greek government. By making public administration decisions readily available, the platform has created a culture of openness, allowing citizens to scrutinise government actions and hold public officials accountable. This transparency has helped to reduce corruption, increase public trust, and foster a more accountable government. **[15]** The Diavgeia project has transformed the government information landscape in Greece by introducing transparency, accountability, and open access to public administration decisions. It has empowered citizens, improved governance practices, and inspired similar initiatives worldwide, creating a more open and informed society. **[16]**

The records classification on the platform is essential for effective information retrieval and analysis. However, ensuring accurate and consistent multiple-subject classification can be complex. The uploading of documents to the Diavgeia portal is done manually by university employees in a structured digital environment. The type of university actions and the subject categories are manually selected from the corresponding drop-down lists **[Fig. 1-2]**. This practice creates confusion between the type of document and its subject categories indexing.

Records published on Diavgeia cover a wide range of subjects and topics, reflecting the diverse activities of public administration. The subject matter can vary from legal and regulatory matters to infrastructure projects, public procurement, and personnel issues. Categorising such diverse content can be challenging, as decisions may touch on multiple subjects or fall into ambiguous categories. With this method, among others, a part of the university's administrative function is classified and open. On the other hand, the subject assignment of a document may not always align perfectly with the content or scope of the document. Interpreting and assigning relevant subject categories can be subjective, leading to potential confusion or misclassification.

The University of West Attica has uploaded 73.550 records from 2018 **[17]** until the end of 2022 in the Diavgeia portal **[Fig.3, Table 2, 3]**. The critical question is to what extent the structure of the Diavgeia portal reflects the origin and original order of the university's records. Especially if we consider it a broader service that applies to many different public sector organisations with various characteristics. To evaluate the effects of machine learning technologies on subject classifications, we could collect university records from Diavgeia Portal and implement machine learning model training and prediction.

The Diavgeia portal administrators must continually review and refine their classification system to address the abovementioned challenges. Implementing automated or semi-automated techniques, such as natural language processing or machine learning algorithms, can improve document classification accuracy and consistency. These

technologies can analyse the textual content of documents and suggest appropriate document types and subject categories based on patterns and predefined rules.

Furthermore, feedback mechanisms and user engagement can be vital in identifying and rectifying misclassifications. Users of the Diavgeia portal can report inaccuracies or provide suggestions for improvement, allowing administrators to make necessary adjustments to enhance the classification process.

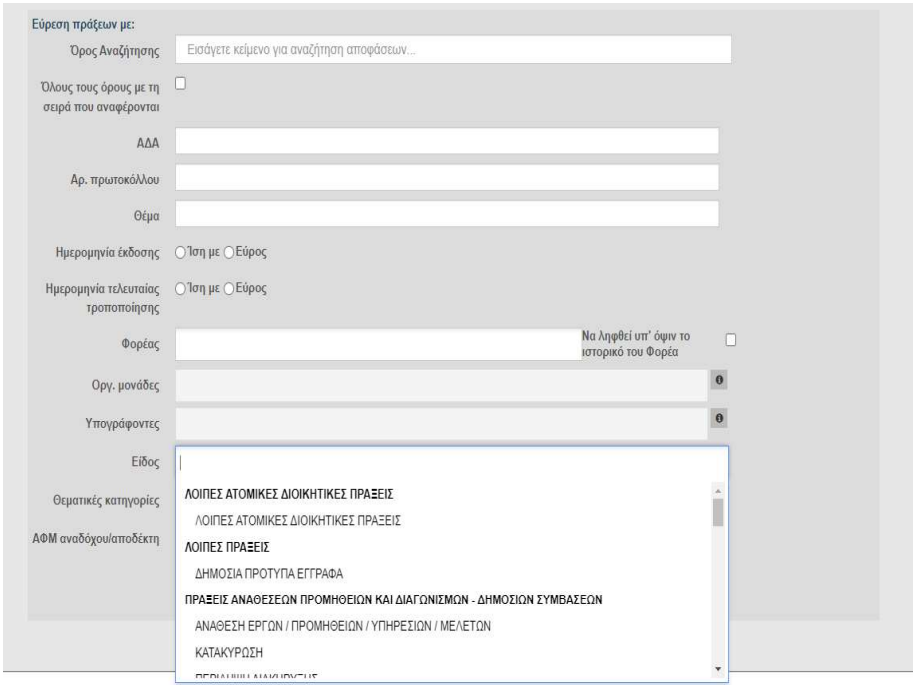

Fig. 1. Type of Government Actions on Diavgeia portal

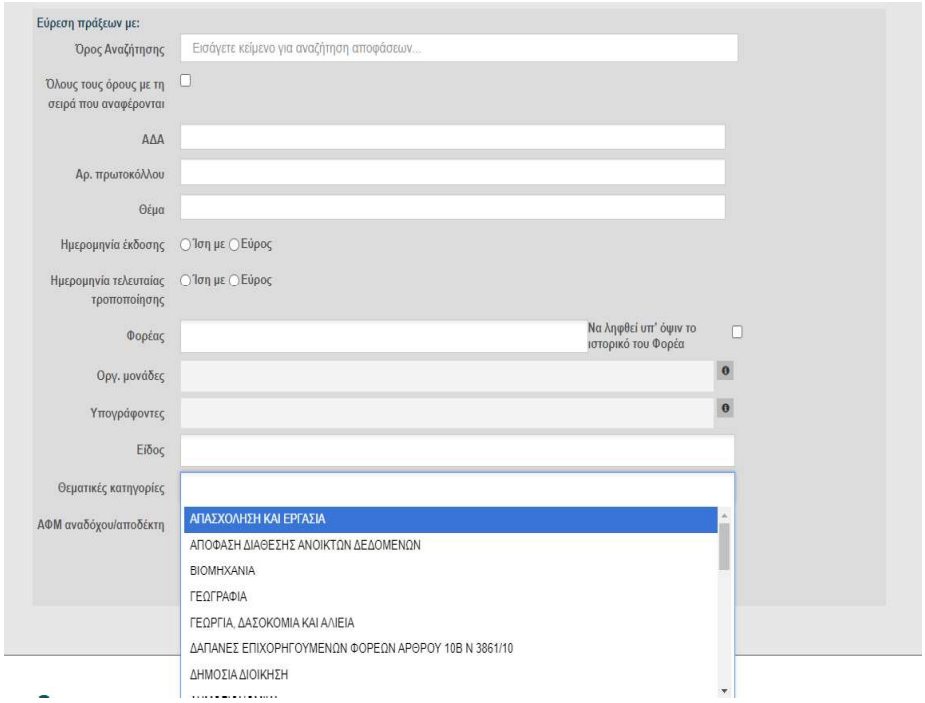

Fig. 2. Subject Categories of Government Actions on Diavgeia portal

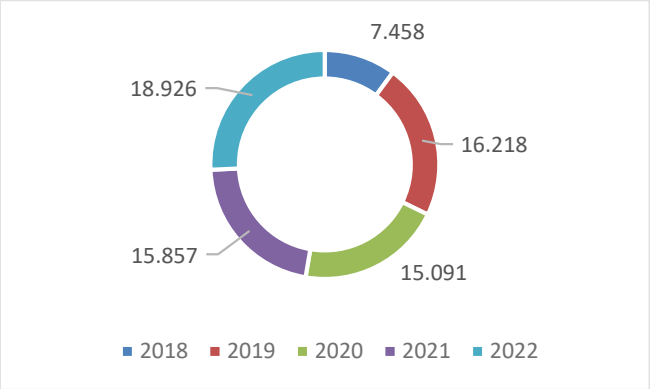

Fig. 3. Total number of entries on Diavgeia portal by the University of West Attica per year

Type of University Action (single)	Number
<type>ΕΓΚΡΙΣΗ ΔΑΠΑΝΗΣ</type>	30.268
<type>ΑΝΑΛΗΨΗ ΥΠΟΧΡΕΩΣΗΣ</type>	12.808
<type>ΛΟΙΠΕΣ ΑΤΟΜΙΚΕΣ ΔΙΟΙΚΗΤΙΚΕΣ ΠΡΑΞΕΙΣ</type>	5.412
<type>ΑΝΑΘΕΣΗ ΕΡΓΩΝ / ΠΡΟΜΗΘΕΙΩΝ / ΥΠΗΡΕΣΙΩΝ / ΜΕΛΕΤΩΝ</type>	5.134
<type>ΕΓΚΡΙΣΗ ΠΡΟΥΠΟΛΟΓΙΣΜΟΥ</type>	5.108
<type>ΚΑΝΟΝΙΣΤΙΚΗ ΠΡΑΞΗ</type>	4.968
<type>ΟΡΙΣΤΙΚΟΠΟΙΗΣΗ ΠΛΗΡΩΜΗΣ</type>	4.901
<type>ΠΡΑΞΗ ΠΟΥ ΑΦΟΡΑ ΣΕ ΣΥΛΛΟΓΙΚΟ ΟΡΓΑΝΟ - ΕΠΙΤΡΟΠΗ - ΟΜΑΔΑ ΕΡΓΑΣΙΑΣ - ΟΜΑΔΑ ΕΡΓΟΥ - ΜΕΛΗ ΣΥΛΛΟΓΙΚΟΥ ΟΡΓΑΝΟΥ</type>	3.950
<type>ΣΥΜΒΑΣΗ</type>	494
<type>ΠΕΡΙΛΗΨΗ ΔΙΑΚΗΡΥΞΗΣ</type>	269
<type>ΥΠΗΡΕΣΙΑΚΗ ΜΕΤΑΒΟΛΗ</type>	105
<type>ΠΡΟΚΗΡΥΞΗ ΠΛΗΡΩΣΗΣ ΘΕΣΕΩΝ</type>	56
<type>ΙΣΟΛΟΓΙΣΜΟΣ – ΑΠΟΛΟΓΙΣΜΟΣ</type>	39
<type>ΔΙΟΡΙΣΜΟΣ</type>	20
<type>ΠΡΑΞΗ ΠΟΥ ΑΦΟΡΑ ΣΕ ΘΕΣΗ ΓΕΝΙΚΟΥ - ΕΙΔΙΚΟΥ ΓΡΑΜΜΑΤΕΑ - ΜΟΝΟΜΕΛΕΣ ΟΡΓΑΝΟ</type>	11
<type>ΚΑΤΑΚΥΡΩΣΗ</type>	3
<type>ΠΡΑΞΕΙΣ ΧΩΡΟΤΑΞΙΚΟΥ - ΠΟΛΕΟΔΟΜΙΚΟΥ ΠΕΡΙΕΧΟΜΕΝΟΥ</type>	2
<type>ΔΩΡΕΑ - ΕΠΙΧΟΡΗΓΗΣΗ</type>	1
<type>ΕΓΚΥΚΛΙΟΣ</type>	1

Table 2. Number of entries per Type of University Action

Subject of University Action (multiple)	Number
<subject>ΠΑΡΑΓΩΓΗ, ΤΕΧΝΟΛΟΓΙΑ ΚΑΙ ΕΡΕΥΝΑ</subject>	42.147
<subject>ΕΠΙΣΤΗΜΕΣ</subject>	38.513
<subject>ΟΙΚΟΝΟΜΙΚΕΣ ΚΑΙ ΕΜΠΟΡΙΚΕΣ ΣΥΝΑΛΛΑΓΕΣ</subject>	14.674
<subject>ΕΠΙΚΟΙΝΩΝΙΑ ΚΑΙ ΜΟΡΦΩΣΗ</subject>	14.553
<subject>ΔΗΜΟΣΙΟΝΟΜΙΚΑ</subject>	6.980
<subject>ΑΠΑΣΧΟΛΗΣΗ ΚΑΙ ΕΡΓΑΣΙΑ</subject>	650
<subject>ΔΗΜΟΣΙΑ ΔΙΟΙΚΗΣΗ</subject>	299
<subject>ΟΙΚΟΝΟΜΙΚΗ ΖΩΗ</subject>	8
<subject>ΔΑΠΑΝΕΣ ΕΠΙΧΟΡΗΓΟΥΜΕΝΩΝ ΦΟΡΕΩΝ ΑΡΘΡΟΥ 10Β Ν 3861/10</subject>	4
<subject>ΕΝΕΡΓΕΙΑ</subject>	4
<subject>ΕΠΙΧΕΙΡΗΣΕΙΣ ΚΑΙ ΑΝΤΑΓΩΝΙΣΜΟΣ</subject>	2
<subject>ΑΠΟΦΑΣΗ ΔΙΑΘΕΣΗΣ ΑΝΟΙΚΤΩΝ ΔΕΔΟΜΕΝΩΝ</subject>	1
<subject>ΕΥΡΩΠΑΪΚΗ ΈΝΩΣΗ</subject>	1
<subject>ΥΓΕΙΑ</subject>	1
<subject>ΒΙΟΜΗΧΑΝΙΑ</subject>	0
<subject>ΓΕΩΓΡΑΦΙΑ</subject>	0
<subject>ΓΕΩΡΓΙΑ, ΔΑΣΟΚΟΜΙΑ ΚΑΙ ΑΛΙΕΙΑ</subject>	0
<subject>ΔΙΑΤΡΟΦΗ ΚΑΙ ΓΕΩΡΓΙΚΑ ΠΡΟΪΟΝΤΑ</subject>	0
<subject>ΔΙΕΘΝΕΙΣ ΟΡΓΑΝΙΣΜΟΙ</subject>	0
<subject>ΔΙΕΘΝΕΙΣ ΣΧΕΣΕΙΣ</subject>	0
<subject>ΔΙΚΑΙΟ</subject>	0
<subject>ΚΟΙΝΩΝΙΚΑ ΘΕΜΑΤΑ</subject>	0
<subject>ΜΕΤΑΦΟΡΕΣ</subject>	0
<subject>ΠΕΡΙΒΑΛΛΟΝ</subject>	0
<subject>ΠΟΛΙΤΙΚΗ ΖΩΗ</subject>	0

Table 3. Number of entries per Subject of University Action

The absence of standardised subject categories across all public administration entities in Greece poses a challenge to the consistent categorisation of Diavgeia. Different entities may use different classification schemes or terminologies, making establishing a uniform and comprehensive subject taxonomy difficult. This lack of standardisation can hinder effective information retrieval and cross-referencing of related records. Public administration decisions often involve complex subject matter that requires in-depth understanding and expertise to categorise accurately. Decisions may involve technical, legal, or specialised terminology that requires domain knowledge for proper classification. Ensuring that subject categories capture the nuanced aspects of the decisions can be challenging, particularly when limited contextual information is provided. In addition, the subject categories on Diavgeia must adapt to the evolving nature of public administration and address emerging topics or issues. New policy areas, technological advancements, or societal changes may introduce subjects not previously accounted for in the categorisation scheme. Regular updates and adjustments to the subject categories are necessary to ensure the relevance and coverage of the platform. To address these challenges, Diavgeia needs to establish a well-defined and comprehensive subject taxonomy that reflects the breadth of public administration activities. This taxonomy should be developed in consultation with relevant stakeholders, including public administration entities, subject matter experts, and platform users. Regular reviews and updates of the subject categories are essential to accommodate changes and evolving needs. Additionally, providing guidelines and training to public administration entities regarding subject categorisation can help improve

consistency and accuracy. Encouraging feedback and collaboration from users of Diavgeia can also assist in refining the subject categories and addressing any ambiguities or gaps.

The proposed research aims to investigate the impact of machine learning technologies on the classification of records at the University of West Attica. A similar methodology has been applied to other aspects of academic activity, such as the repository of the scientific activity of university members. **[18, 19]** It has to be mentioned that the etchings of applying machine learning practices to archival practices differ in their use in digital libraries and repositories. Striking a balance between AI technologies and human expertise will be crucial in leveraging the benefits of AI while upholding the core principles and values of archival practice. **[20]**

By exploring the potential effects, this research seeks to improve record management practices and enhance the accessibility and retrieval of archival materials within the university. The research question is clearly stated, focusing on the specific context of the University of West Attica and the application of machine learning technologies. Potential research outcomes could include improved accuracy and consistency in subject categorisation, enhanced efficiency in record management processes, and increased discoverability of records within the University of West Attica. The research may also identify challenges, limitations, or ethical considerations associated with applying machine learning technologies in subject classification. The research has practical implications for the University of West Attica and similar institutions. If the study demonstrates positive effects, machine learning technologies could significantly streamline and automate the subject categorisation process, reducing manual effort and improving the overall productivity of record management staff. The findings can inform the development of guidelines and best practices for implementing machine learning services for subject categorisation within the university's record management framework. In addition, it is possible to test methodologies applied in a different context and produced valid results. **[21]**

V. Conclusion

The dynamic relationship between archival science and machine learning practices and, more broadly, AI is ongoing and can reshape theoretical and methodological schemes. By embracing these technologies within the framework of the Records Continuum model, organisations can effectively manage born-digital archives, ensuring their long-term preservation and facilitating their valuable contribution to research, historical documentation, and organisational memory. **[22]**

In conclusion, this theoretical paper investigated the application of machine learning technologies in archives and records management, with a particular focus on government actions. The research hypothesis was that integrating machine learning technologies can significantly improve the efficiency, accuracy, and accessibility of the University of West Attica records. Through automated technologies, ongoing refinement of classification systems, and user engagement, efforts can be made to minimise confusion and improve the overall effectiveness of the portal in delivering reliable and well-categorised information to the public. By embracing these technologies, academic institutions can enhance the efficiency, accuracy, and accessibility of their records, ultimately benefiting researchers, administrators, and the wider society. As the field of archival science continues to evolve, further research and collaboration between archivists, data scientists, and stakeholders will be vital to fully realise the potential of machine learning in transforming university records management practices.

VI. References

[1] Sweeney, S. (2008). The ambiguous origins of the archival principle of "provenance". *Libraries & the Cultural Record*, *43*(2), 193-213. https://www.jstor.org/stable/25549475

[2] Hensen, S. L. (1993). The first shall be first: APPM and its impact on American archival description. *Archivaria*, *35*, 64-70. https://www.archivaria.ca/index.php/archivaria/article/view/11886

[3] Duranti, L. (1998). *Diplomatics: New Uses for an Old Science. Lanham*, MD: Scarecrow Press, in association with the Society of American Archivists and Association of Canadian Archivists, 177.

[4] Duranti, L. (2001). The impact of digital technology on archival science. *Archival Science*, *1*(1), 39-55. https://doi.org/10.1007/BF02435638

[5] Pandey, N., Sanyal, D. K., Hudait, A., & Sen, A. (2017). Automated classification of software issue reports using machine learning techniques: an empirical study. *Innovations in Systems and Software Engineering*, *13*, 279-297. https://doi.org/10.1007/s11334-017-0294-1

[6] Yakel, E., & Torres, D. (2003). AI: Archival intelligence and user expertise. *The American Archivist*, *66*(1), 51-78.

[7] Manghi, P., Mikulicic, M., & Atzori, C. (2012). De-duplication of aggregation authority files. *International Journal of Metadata, Semantics, and Ontologies*, *7*(2), 114-130. https://doi.org/10.17723/aarc.66.1.q022h85pn51n5800

[8] Niu, Y., Ying, L., Yang, J., Bao, M., & Sivaparthipan, C. B. (2021). Organisational business intelligence and decision making using big data analytics. *Information Processing & Management*, *58*(6), 102725. https://doi.org/10.1016/j.ipm.2021.102725

[9] Fennelly, L. J. (2014). *Museum, archive, and library security*. Butterworth-Heinemann.

[10] Stančić, H. (2018). Computational archival science. *Moderna Arhivistika*, *1*(2), 323-330. Computational-Archival-Science.pdf (researchgate.net)

[11] Traub, M. C., Van Ossenbruggen, J., & Hardman, L. (2015). Impact analysis of OCR quality on research tasks in digital archives. In *Research and Advanced Technology for Digital Libraries: 19th International Conference on Theory and Practice of Digital Libraries, TPDL 2015, Poznań, Poland, September 14-18, 2015, Proceedings 19* (pp. 252-263). Springer International Publishing. https://doi.org/10.1007/978-3-319-24592-8_19

[12] Jo, E. S., & Gebru, T. (2020, January). Lessons from archives: Strategies for collecting sociocultural data in machine learning. In *Proceedings of the 2020 conference on fairness, accountability, and transparency* (pp. 306-316). https://doi.org/10.1145/3351095.3372829

[13] Thibodeau, K. (2018, December). Computational Archival Practice: Towards A Theory for Archival Engineering. In *2018 IEEE International Conference on Big Data (Big Data)* (pp. 2753-2760). IEEE. https://doi.org/10.1109/BigData.2018.8622174

[14] Chrysanthopoulos, C., Drivas, I., Kouis, D., & Giannakopoulos, G. (2023). University archives: the research road travelled and the one ahead. *Global Knowledge, Memory and Communication*, *72*(1/2), 44-68. https://doi.org/10.1108/GKMC-08-2021-0128

[15] Karamagioli, E., Staiou, E. R., & Gouscos, D. (2014). Government spending transparency on the internet: an assessment of Greek bottom-up initiatives over the Diavgeia Project. *International Journal of Public Administration in the Digital Age (IJPADA)*, *1*(1), 39-55. https://doi.org/10.4018/ijpada.2014010103

[16] Mastora, A., Koloniari, M., & Monopoli, M. (2021). The Government Information Landscape in Greece. *IFLA Professional Reports*, 64-82. The Government Information Landscape in Greece - ProQuest

[17] The University of West Attica (UNIWA) was founded in March 2018 by the National Law 4521.

[18] Vorgia, F., Triantafyllou, I., & Koulouris, A. (2017). Hypatia Digital Library: A text classification approach based on abstracts. In *Strategic Innovative Marketing: 4th IC-SIM, Mykonos, Greece 2015* (pp. 727-733). Springer International Publishing. https://doi.org/10.1007/978-3-319-33865-1_89

[19] Triantafyllou, I., Vorgia, F., & Koulouris, A. (2019). Hypatia Digital Library: A novel text classification approach for small text fragments. *Journal of Integrated Information Management*, *4*, 16-23. https://doi.org/10.26265/jiim.v4i2.4420

[20] Cushing, A.L. and Osti, G. (2023), ""So how do we balance all of these needs?": how the concept of AI technology impacts digital archival expertise", *Journal of Documentation*, *79*(7), pp. 12-29. https://doi.org/10.1108/JD-08-2022-0170

[21] Triantafyllou, I., Drivas, I. C., & Giannakopoulos, G. (2020). How to Utilise my App Reviews? A Novel Topics Extraction Machine Learning Schema for Strategic Business Purposes. *Entropy*, *22*(11), 1310. https://doi.org/10.3390/e22111310

[22] Colavizza, G., Blanke, T., Jeurgens, C., & Noordegraaf, J. (2021). Archives and AI: An overview of current debates and future perspectives. *ACM Journal on Computing and Cultural Heritage (JOCCH)*, *15*(1), 1-15. https://doi.org/10.1145/3479010

VII. AUTHORS

Ioannis Triantafyllou holds a PhD from the National Technical University of Athens, Department of Electrical & Computer Engineering, and is currently an Associate Professor at the Department of Archives, Library and Information Studies at the University of West Attica. He has previously worked as a research associate in many European and Greek research projects at the Institute of Language & Speech Processing (ILSP / Athena RC). Recently, he participated in the CrossCult research program (Horizon2020) as a research team member. He specialises in Digital Libraries, Data & Text Mining, Text Classification & Clustering, Ontologies & Metadata, Linked Data, Information Extraction, Text & Information Retrieval, Automated Summary & Text Synthesis, Translation Memories, etc.

Christos Chrysanthopoulos is a PhD candidate at the University of Patras (GR), Department of History and Archaeology (former Department of Cultural Heritage Management and New Technologies). His doctoral research focuses on "Digital Public History". He is an Academic Fellow on Archival Science at the Department of Archival, Library and Information Studies at the University of West Attica. He works as a Special Scientific-Technical Staff [Humanities, Projects and grants management specialist] at the Institute of Historical Research of the National Hellenic Research Foundation. He obtained his BA in History (University of Thessaly Department of History, Archaeology and Social Anthropology), and he continued with a fast-track graduate entry for a second BA in Archival, Library and Information Studies (University of West Attica). He received a Master's Degree (M.Sc.) in Modern and Contemporary History (the Panteion University of Social and Political Sciences Department of Political Science and History) and a Master of Education (M.Ed.) in Adult Education (Hellenic Open University-School of Humanities).

Yannis Stoyannidis studied History at the Department of History, Archaeology and Social Anthropology of the University of Thessaly, from which he received his Master of Arts (M.A.) and his PhD. His research interests include archives management, social history, urban history and the history of institutions, and he has published several articles in scientific journals and conference proceedings. He has participated in various research programs concerning social history, industrial heritage and archive management. Currently, he is an Assistant Professor at the Department of Archival, Library and Information Studies, University of West Attica.

Dr. Anastasios Tsolakidis received his PhD degree in computer science from the University of Limoges, France, in 2015. His research interests lie in the fields of Visual Analytics, Decision Support Systems, Business Intelligence and E-health. During his PhD studies, he has been collaborating with the Quality Assurance Unit of the Technological Educational Institute of Athens, as Data Scientist and since the July 2017 he has been working as Business Intelligent Analyst at "e-Government Center for Social Security (IDIKA SA)" at the sector of E-Health.

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Everyday photos as tools to enhance the museum experience

Angeliki Antoniou[1], **Susana Reboreda Morillo**[2], **Eftychia Vraimaki**[1]
[1]Department of Archival, Library & Information Studies, University of West Attica, [2]Department of History, Art and Geography, University of Vigo
angelant@uniwa.gr [**ORCID**: 0000-0002-3452-1168], rmorillo@uvigo.es [**ORCID**: 0000-0002-4886-2078], evraimaki@gmail.com [**ORCID**: 0000-0002-3393-2926]

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Abstract:

Purpose *- Inspired by a recent museum visit, the present work wished to study the effect of the use of photos in cultural technologies.*

Design/methodology/approach *- We used ancient museum objects with contemporary photos, showing people performing similar activities in antiquity and today. Qualitative data from interviews were collected and analyzed to study the participant's reflections when they saw the images of ancient objects and contemporary photos.*

Findings *- Results revealed the importance of contemporary photos and the possibility of including them in cultural heritage technologies since they assist visitors in understanding and reflection processes.*

Originality/value *- Photos can function as interpretation aids and also allow participants to make multiple connections between past and present, across societies and cultures, between current and prior knowledge, and permit connections to personal experience, leading to the conclusion that critical constructivist approaches take place when people are presented with the two images and meaning-making processes.*

Index Terms **—** museum contextualization, visitor meaning making, photography, constructivism, design requirements.

I. Introduction

In Chalcis, a city in Euboea (Greece) with a vibrant history from ancient, Roman, byzantine, ottoman, and industrial times and with multicultural communities throughout its history, the New Archeological Museum "Arethousa" presents artefacts and (hi)stories from different eras and communities.

In January 2022, we visited the museum and observed an interesting video installation presenting different museum items. The presentation of each museum item was followed by a relevant modern photograph, showing people performing similar activities as the ones depicted in the ancient art. The video installation did not use any textual or oral information. It simply showed images one after another. The museum has released a short video on social media, presenting a small part of the installation. Looking at this installation, specific questions emerged:

- What kind of connections do visitors make when looking at this photo sequence?
- Can visitors extract meaning from this particular video installation?
- What are the visitors' reflective processes when exposed to this video?
- Can contemporary photos be used in advanced cultural heritage technologies to assist construction further meaning?

In order to further explore these questions, we designed the present study, which collected qualitative data from participants and studied the potential of images to provide adequate information and triggers for meaning-making and reflection. The scientific community has discussed the first three research questions, as it will be explained in section 3, but not within the context of an archaeological museum. The last research question is the authors' idea since, to the best of our knowledge, there are no explicit guidelines for the use of contemporary photos in technologies used in museums. Our visit to the Archaeological Museum of Chalcis inspired us to study further everyday photos' role in museum meaning-making.

II. How do visitors handle museum information?

Most museums started their operation in the 18th century, but soon after their establishment, voices criticised the practice of keeping items inside museum walls. In one of the most famous quotes from 1843, Norwegian painter J.C. Dahl warns, "Nature preserves while museums destroy" **[1]**. Removing items from their original environment implied that a significant amount of vital information around their interpretation was gone. Imagine, for example an ancient statue meant to be inside a sanctuary that ends up in a museum, away not only from the building in which it was meant to be but also from all the other surrounding items that once stood inside the sanctuary **[2]**. This issue is described as the museum contextualization problem.

Due to the immense importance of context in understanding cultural objects inside museums **[3]**, museums worldwide apply different means to provide the necessary interpretation context for visitors **[4]**. From maps **[5]** to models **[6]**, dioramas **[7]**, and information labels **[8],** museums try to provide the information needed for visitors. Technology is also often employed to provide context for museum objects. For example, Augmented Reality can project the museum item in its original environment **[9]**. Thus, the importance of context is widely recognized as a necessary requirement for understanding cultural items, the complex interrelationships around them, and the creation of meaning **[10]**. Therefore, context is vital in discovering knowledge and processing information as a whole to maximize cognitive gains **[11]**.

In addition, museum visitors' meaning-making processes are also known as constructivist and researchers view modern museums as constructivist learning environments **[12, 13]**. Visitors use their prior knowledge and personal experiences to build cognitive schemas that accommodate the new information. To do so, they rely on known social and cultural practices, like traditions, cultural practices, customs, language, etc. **[14]**.

However, in order to engage in meaning-making, visitors' attention must be captured, and they must feel motivated to think further. Museums have used different approaches to capture visitor attention and enhance engagement (e.g. **[15]**). Researchers have also constructed theoretical models to understand visitor attention elements and ways to augment them **[16, 17]**. One such method was trying to micro-augment the museum experience, which used only nonlinguistic stimuli of a minimum duration to create an information gap and increase visitors' curiosity. In particular, micro augmentations were used in two different forms. In one form, the visitors heard sounds of short duration and intensity from speakers above the exhibits that released sonic beams, resulting in highly localized sounds **[18]**. In the other form, micro augmentations were used to provide color on ancient statues but only for one second. The color appeared and quickly disappeared without any other information **[19]**. In both cases, visitors were intrigued, and showed increased curiosity and learning motivation.

Regarding the use of photographs in museums, these are also used to provide information to visitors, often as an alternative or addition to text. According to Edwards & Lien **[20],** photographs can provide museum context and enhance museum exhibitions **[21, 22, 23]**. Consistent with the constructivist tradition, photographs in museums allow visitors to experience alternative viewpoints, provide many layers of historical and cross-cultural experiences **[24]**, and enrich visitors' meaning-making processes. Thus, the present work wishes to study how photographs and what type of photographs can relate to ancient art objects, if and how they allow visitors in meaning-making, and what reflective processes they evoke.

CONTENT IN MUSEUM TECHNOLOGIES AND THE USE OF PHOTOS

Museums have used photos since the 1850s to enhance the visitor experience in multiple ways **[25]**. Cultural heritage technologies also use recent photos frequently for different purposes. One of the most expected uses of recent photos is the photos taken by visitors and shared by them on social media. Museums and cultural heritage institutions are aware of this use of photos by visitors, and in some cases, they decide to exploit such practices. For example, Instagram further communicated the museum experience to the public. Visitors used this social media platform to create their narratives about their museum visits while researchers studied how these narratives were created and shared **[26]**. In another example, the Brooklyn Museum used photos uploaded by its visitors on social media, like Instagram and Snapchat, and organized semi-structured interviews to better understand visitor needs [27]. Social media like Instagram have offered tools to the public that were previously only available to professionals, thus making photography more accessible and easier to share and changing the visual meaning-making over time **[28]**. By taking photographs, people engage in an embodied experience that requires them to touch, rub, and click to get photos and share them on social media. These embodied actions increase involvement and meaning-making **[29]**. Embodied interaction can be viewed as a way to interpret the museum content **[30]**.

Social sciences have used photos to understand people's perceptions and behavior; over the years, multiple methods have been used **[31]**. Especially in ethnographic research, photos are practical tools to elicit deeper thinking from participants and help engage in deeper meaning-making processes **[32]**. In this light, researchers have specifically asked museum visitors to take photos of items that captured their attention to provide data for further analysis **[33]**. In another study, students were asked to take photos during their museum visit to exercise their critical thinking and history learning **[34]** since photographs have been successfully used in the educational domain and seem to enhance learning and visual literacy **[35]**. Photos have also been used by museums to increase empathy and perspective-taking. Presenting specific historical events at a museum, i.e. apartheid in South Africa, photos made people better understand the historical events and the perspectives of different racial groups **[36]**.

To extract meaning from people's photographs, a theoretical framework is needed that will consider the person who took the photo, the researcher who will analyze it and the context of the process. In the framework of interpretive engagement, five elements are considered necessary: the researcher, the participant, the image and the context of its production and the audience/s. Thus, museums can only understand what visitor images mean when considering all the above elements **[37]**. In a study by Loeffler **[38],** photos were used to extract meaning through a photo-elicitation interview. Participants explained their photos to the researchers from an outdoor activity. As

photos were explained and analyzed, researchers identified some recurring themes: connection with the physical space, connections with others, self-discovery and gaining perspectives.

Photos have also been used to provide further context for archaeological items. In a study by Antoniou et al. **[9],** visitors could see the museum objects through their mobile phones while in the background, they could also see 360 photos of the original excavation site that the objects came from. Photos were in this case implemented in the Augmented Reality (AR) application that allowed the museum items to be viewed in relation to their original site. Museums also know that the way photos are presented within an exhibition can change the meaning of the exhibition. In other words, the presentation order and the placement of photos in the physical environment of the exhibition can significantly alter the meaning-making processes **[39].** In addition, photos seem to change the understanding of historical phenomena when used in museums **[40]**. As a Docket et al. [41] study revealed, one visual element might provide information without an interpretation context. Two or more photos seen together allow different connections to emerge and assist understanding and reflection.

Furthermore, photographs of relevant themes to the museum and its items are highly effective in visitor interpretations **[42]**. Photographs do not simply work as cues in an interpretation process, but they are meaningful artefacts that assist interpretation of the past and reflection. Photos seem to boost remembering of relevant ideas, stimulation of emotions, production of narratives, association discovery and therefore, meaning-making **[43]**.

Different projects have used photos to enhance the user experience. The H2020 EU project CrossCult **[44]** used photos of ancient and contemporary items to enhance visitor reflections and allow them to make easy connections between objects, concepts and different cultures. For example, the narrative discussing how people use clothing as a code to convey messages about themselves to others used the photos of ancient museum statues and teenagers around the world today, etc. **[44]**. In addition, "muse" is a project that will use the photos taken by visitors during their visit to extract valuable information for museums through data analytics and allow them to know their visitors better. A similar concept was implemented by the ArtClix project, where visitors were encouraged to take multiple photos and share them with friends. The museum again gained valuable insight into the user experience, and the visitor was also actively engaged with the exhibits **[45]**. The EU project GIFT allowed visitors to use photos to personalize museum items that could then be 3D printed and given to the visitor as a personalized item from her museum experience. Finally, museums worldwide, like the Smithsonian National Air and Space Museum, use different photographs to allow visitors to engage better with the exhibits since photos provide images of the items in use (e.g. aeroplanes flying).

Museum narratives delivered through technology often use photos to enrich the stories **[46]**. As museum human guides use the actual exhibits to unfold their narratives **[47]**, technology-assisted tours use different photos to provide information in multiple modalities maximizing their (learning) effect **[48]**. The importance of photos in narratives leads to the automatic generation of themed photo narratives that go beyond the museum visit **[49].**

However, although frequently used by cultural technologies, different uses of photos seem to be used intuitively by researchers without a structured framework for their use. The present work aims to study their actual interpretation power and reveal how people perceive photos in a museum setting.

Finally, the main objective of the present work is to study the effect of everyday photos as tools that assist visitors meaning-making processes. In addition, we explore the potential of photos to be used in current museum technologies to enhance the visitor experience and allow easy construction of meaning.

III. METHODOLOGY

A. Participants

The researchers made an open call within their institutions for volunteering students to participate in the study. The first ten would be called in for participation. All participants were familiar with ancient Greek civilization, since they were students of History and/or Archaeology and/or Archival and Library Studies. We chose participants with a specialized background because we wished to remove possible novelty effects from introducing objects that participants would be unfamiliar with. In addition, based on Sandelowski **[50],** ten participants may be judged adequate for homogeneous sampling in qualitative research when the issues studied are not of high complexity. In this case, the phenomenon studied was of low complexity, and the participants were all of a specialized background. However, because of the sampling process, the results would be biased and cannot be generalized to the general population. The importance of this work lies in showing photography's possible effects in visitor reflection processes and revealing issues for future exploration.

All participants were students either at the University of Vigo or the University of West Attica. There were ten participants in total. The profiles of the participants are as follows:

Participant 1 (P1l): Greek-speaking, male, background in Archival, library & information studies.

Participant 2 (P2l): Greek-speaking, female, background in Archival, library & information studies.

Participant 3 (P3h): Spanish-speaking, Historian specializing in free time culture and medieval architecture

Participant 4 (P4l): Greek-speaking, female, background in Archival, library & information studies.

Participant 5 (P5a): Spanish-speaking, Archeologist with a specialization in Greek funerary objects.

Participant 6 (P6h): Spanish speaking, male, history

background but not archaeology

Participant 7 (P7h): Spanish-speaking, female, background in history and Egyptology. Some knowledge of Greek archaeology.

Participant 8 (P8l): Greek-speaking, female, background in Archival, library & information studies.

Participant 9 (P9h): Spanish-speaking, female, background in History and Geography, some knowledge of ancient Greek archaeology

Participant 10 (P10l): Greek-speaking, female, background in Archival, Library and Information Studies.

Since all the archaeological items were from Greek antiquity, it would be easy for Greek-speaking participants to read the inscriptions on some items. The initials a, l and h were added next to the participant number and correspond to their background to assist the reader in easily seeing the participant's background knowledge. (a stands for Archaeology, l for Library studies and h for History).

B. Materials

All the images were shown to the participants with a PowerPoint presentation. All images used had the necessary licenses (Appendix 1).

The link that unites all the selected images is women, establishing connections between their tasks in Ancient Greece and today. Gender studies in History, after some resistance from the Academy, have been integrated into historical research and are considered relevant, also in Antiquity **[51]**. However, museums do not usually have a specific section dedicated to transmitting the knowledge of a fundamental part of societies, such as women. This situation is repeated in all historical periods, and we have selected Ancient Greece, precisely the classical period (479-323 B.C.), a period marked by patriarchal ideology, as can be seen in that only males were fully entitled to acquire citizenship. At the same time, females, at most, were only necessary for its transmission **[52]**. This reality means that the sources of information are less explicit about the female domain than the male domain. For this reason, iconography is a fundamental source for learning about aspects of women's daily lives **[53],** and we have selected the images with the intention that they reflect various essential areas in their lives: domestic activities inside and outside the oikos, aspects that relate the educational system and the role of women **[54,55]**. In addition, we asked participants only to focus on ancient Greek objects since our participants were familiar with ancient Greek civilization, in an attempt to remove novelty elements.

C. Procedure

Students from the 2 Universities were invited to participate in the study. The students that responded were invited to individual Zoom sessions. The material was organized in a PowerPoint presentation and the researcher shared her screen with the participants. The only instructions were that participants should only describe what they see and anything that comes to their mind throughout the presentation. Participants were also informed that there were no right or wrong answers. Participants saw an ancient item and in the next slide they saw the same item together, with a contemporary, relevant photo. This process was repeated 7 times (7 ancient items and 7 relevant photos). We used 7 sets of images to prevent participant fatigue since people's working memory can only handle 7 plus or minus 2 units of information **[56]**. After the end of the presentation, participants were asked if they had any general comments. The session for each participant was about 30 to 40 minutes. Due to the sampling process (university students that might know the researchers), extra measures had to be taken to reduce data biases. The researcher only told students to report what they saw in the photos and anything that came to their minds without any further comments from the researcher. The only two questions used were: "What do you see?" for the first image in the series and "Now, what do you see?" for the first and second images in the series when the images were shown together. The researcher did not provide comments of agreement or disagreement; she simply recorded the answers and continued with the next set of images.

IV. RESULTS

In this section, we will present the participant answers by slide in the same order as in the presentation shown to the participants. For every two slides, we had one theme. We used Soren's classification of cognitive changes when people interact with cultural objects to analyse the data. More specifically, Soren **[57]** observed cognitive changes emerging from interactions with cultural content when people had:

- An opportunity to have experiences with authentic objects.
- An unexpected experience and/or highly emotional experience.
- A new cultural/attitudinal understanding.
- Motivation to become more proactive.
- Realized that historical phenomena had a lasting nature. In essence, historical phenomena are social phenomena, and some still exist today (how certain phenomena are relevant to people of different societies and times).

Researchers have used Soren's classification of visitors' experiences in the past to study visitors' reflective processes. For example, Antoniou et al. **[58]** studied the effect of narratives on museum visitors and the lasting impact of mobile technology before, during and after a cultural visit. Similarly, Poulopoulos et al. **[59,60]** used the same classification to study people's cognitive changes when interacting with cultural content on social media.

In addition, we also used indications of meaning-making constructive processes, like use of personal experience and prior knowledge by participants, as an essential element of a constructionist approach **[61]**, as well as triggers of curiosity and motivation, like uncertainty of participants, leading to information gaps **[18]**.

Theme: Woman handling wool (figures 1, 2)

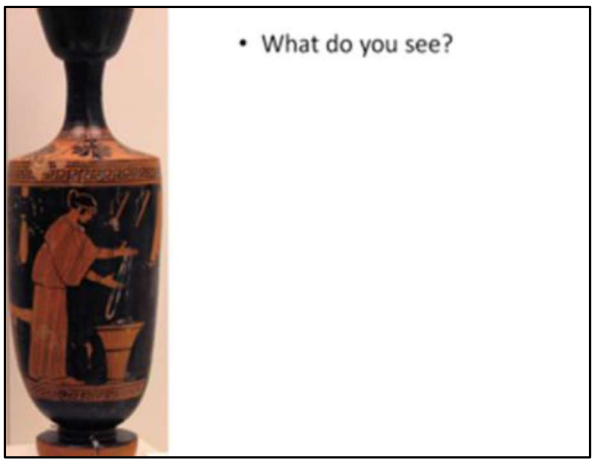

Fig. 1. *Woman handling wool, first slide*

Seeing this image (figure 1), all participants could not understand what the figure was doing. Only 4 people realized that this was a domestic activity, like washing or cooking (P4l,5a,8l,10l). P5a, who is also an archaeologist, specializing in Greek funerary objects, could also not identify the activity and mentioned: "It is a woman, she does some housework, but I cannot say exactly what she is doing". The remaining 6 participants used their imaginations and offered explanations like music playing (P3h), ceremonial activity and ritual (P6h,7h), or even handling of a snake (P2l). The lack of context as also pointed out by P7h, leads to uncertainty. P7h: "A type of vessel with specific decoration. The main figure is a woman involved in a ritual using specific objects depicted in the scene. The vessel is for liquid. The activity of the figure does not involve liquids. It is very difficult to understand the scene because we do not have context". Participants show uncertainty when they describe the image and discuss that necessary information is missing to understand the object further.

Fig. 2. *Woman handling wool, second slide*

When participants saw the following image (figure 2), most of them expressed their surprise as they realized what they saw. P3h said: "Ah! She is working with wool. She is doing the same in antiquity in the first photo". Most immediately connected the two images, even though they were not asked to do so and realized that these women were doing the same type of work. P6h: "I can see an old woman working with tissues or animal hair, maybe with wool. Now I can see similarities in both images… I think the first one could be something similar or even the same. It seems like a daily activity". It was only P2l that did not directly connect the two images regarding wool handling, and she only found general similarities: "An old lady ... but I cannot know what this is ... is it what pillows have inside? Goose feathers? What exactly is this white thing she is holding? In the 2 photos 2 women are doing some manual work ... just that they do some work". Nine out of ten participants correctly identified the activity in both images and connected the past with the present, showing signs of constructivist learning since the presence of the two images together seemed to provide the necessary context.

Theme: Women carrying water (figures 3,4)

Fig. 3. *Women carrying water, first slide*

Almost all participants identified the scene (figure 3) correctly with more or less confidence, apart from P2l that thought that it was some kind of celebration. P1l for example, was not very confident when he said: "I see girls in something like an aqueduct. On the right I see a fountain and a girl filling up water. I see some girls with amphorae on their heads. And perhaps they are discussing". However, all the other participants were very confident with their answers. P9h also went a step further and explained how she knew what this was, based on her prior knowledge: "A woman with a vase on her head. This reminds me of something recent… They are working to get water from a fountain. They are also talking". For the majority of the participants the information in the object was adequate for them to make connections to their previous knowledge and correctly identify the activity shown.

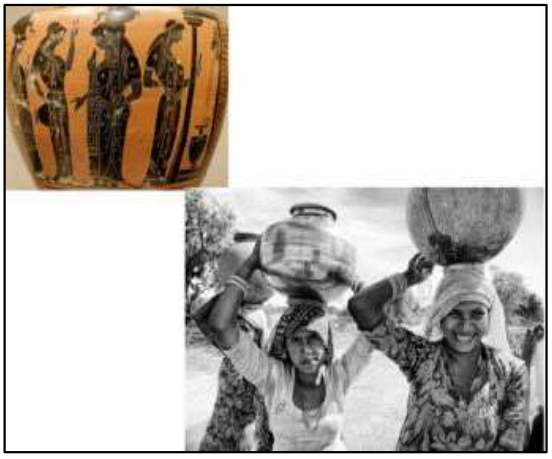

Fig. 4.*Women Carrying water, second slide*

Thus, when participants saw the next slide (figure 4), they were not surprised and simply confirmed what they had stated previously. Even P2l, who did not understand that the women in both figures carry water, nevertheless stated, "They do exactly the same thing (as in the previous photo), but much later in time. They have jars on their heads. Because I see a woman happy, it must be a celebration. Because I see grandma, mom and granddaughter, it must be something like a custom or a celebration. They do the same in both photos". It was also interesting that P1l and 7 made connections to their prior knowledge when they described the images: P1l: "I also see girls perhaps from Africa because I have seen documentaries like that. Perhaps something similar happened with the amphorae. This image is from Africa or Asia". P7h: "They also carry vessels with liquid on their heads. This is typical for cultures in Asia, Africa and South America. A daily life activity too". Finally, P8l connected past and present across cultures when she said: "Exactly the same process in modern times and in a different country". Thus, the second image functions as a confirmation of a hypothesis most participants had formed. The fact that images like the ones in figure 4 are often shown in documentaries from around the world helped participants make connections between the past and the present, enhanced cultural understanding and allowed them to build on their previous knowledge.

Theme: Girl playing (figures 5,6)

Fig. 5. *Girl playing, first slide*

Regarding the theme of the playing girl (figure 5), three participants were sure when they said this is a girl playing (P2l,4l,5a). P2l: "This is a little girl holding a toy. The girl is holding a doll, and (there) is also a goose that obeys like a dog, so it must have been a pet of the time". Although four more participants mentioned that this must be a scene of a girl playing, they were not very sure about it (P1l,7h,8l,9h). P9h: "Is she holding a doll? Is this a bird? or a duck? I do not know what she is doing because she seems like she is holding a doll and has a duck…" P7h being uncertain, also forms a hypothesis for alternative explanation: "It is very interesting. A small girl holding a small figure in front of a duck. Is it a child activity? or do objects like that have another meaning? Because in antiquity, women were also associated with gods". Three participants did not identify the girl in the image and thought it was a woman (P3h,6h,10l). Not realizing this is a girl and thinking it is a woman left the participants puzzled about the activity depicted in the stele, leading to wrong conclusions. P3h: "Seems like a woman is showing a doll to a goose or a duck. Over the duck, I see a ham leg as we have in Spain". The uncertainty of what was shown forced P3h to use personal knowledge and apply it in an attempt to understand the image (i.e. ham leg from Spain). Lack of context seems to lead people to apply prior knowledge (which, in this case, leads to wrong conclusions).

Fig. 6. *Girl playing, second slide*

While most participants simply confirmed what they had suspected from the previous image, when P3h,6h and 10l that were wrong previously saw this slide (figure 6), they were all immediately able to connect the two images and correctly identify the activity in both images. P3h: "Ah! she was a child (referring to the previous image). That makes more sense because of its size". In addition, P5a although she had correctly identified the objects in the first image, after looking at the contemporary one, she makes the connections to today's practices: "We continue playing with the same things today. Perhaps we are more sophisticated but still playing with the same things". The second image provided the necessary context and all participants managed to correctly identify the activity in the ancient object. Participants effectively connected the past with the present

and the two with their personal childhood experiences, understanding the lasting character of the activity.

Theme: Bride's preparation (figures 7,8)

Fig. 7. Bride's preparation, first slide

Eight out of the ten participants were uncertain when they saw this image (figure 7), although most suspect it was an important event, like a celebration of some sort. For example, P1l said: "Two girls. The standing one is trying to decorate the seated one. Perhaps this is a scene from a celebration of some sort that the second girl is spruced up. This thing on top right…I do not know what it is…a balloon? A lamp? They did not have lamps…I do not know". Only three participants were sure this was a bridal preparation, and P2l stated without hesitation: "A girl and someone behind her fixes her hair. She must be a bride".

Fig. 8. Bride's preparation, second slide

However, seeing the next slide (figure 8), most participants understood that this was preparation for an important event, like a wedding. P10l: "A! One woman doing another woman's hair. Could it be for a wedding? or a celebration? So, something similar was also happening in the previous one". By seeing this image, most return to the previous one and reconsider. Many participants made such comparisons between the two images and even observed details they had missed before, like P1l: "I see a wedding scene. I also see a lady taking care of the bride. The first photo could also be a preparation for a celebration. Could this item in the previous photo be a mirror? that is painted like that? or a lantern?" Only P3h remains puzzled and does not realize what these images really show: "She was doing something on her hair. She was supposed to roll this item on her hair. Because the photo had names, it could be goddesses or royalties". Again, in this slide, we observe participants connecting the past and the present and discussing the endurance of cultural phenomena across times. P2l: "This is a similar picture in modern times, where a hairdresser treats a girl to get married. From what I see some ancient customs and habits are preserved to this day". Again here, the second image assists in understanding and connections between past and present. It was easy for participants to realize the lasting nature of the phenomenon and make connections to prior knowledge.

Theme: Family scene (figures 9, 10)

Fig. 9. *Family scene, first slide*

All participants understood that this image (figure 9) was related to a baby. Some called it a birth scene (P1l,6h,9h), others called it a celebration (P1l10l) and even a baby shower party applying today's customs to ancient societies (P3h). We can follow P1l's line of thought: "This is the birth of a little boy and someone on the left is bringing presents. But the little boy is bigger than that…is not born now… what could it be? Like they try to crown the boy? like they are discussing something around the boy? some kind of ceremony around the little boy". Four participants clearly stated that this is a family scene (P2l,4l,5a,9h). P4l: "I see a woman holding the child. A man is in the middle. It may indicate that they are a couple and that they are a family. I will say with reservation that it is a family gathering."

Fig. 10. *Family scene, second slide*

The family scene in the following image (figure 10) made most participants realize that both images show a family. P10l: "And here I see a family. I imagine this was the case in the previous too". Some participants hypothesize that this is a naming ceremony (P1l,8l,9h), while P1l stated that he remained confused even after seeing the second image: "This is a scene from Asia or Africa…or a scene from a baptism? They hug the kid…a scene of affection. Concerning the previous photo, I am a little confused….some kind of ceremony around the little boy…" Nevertheless, after observing the second image, most participants made comparisons to the ancient one. P6h: "I see a family. A woman with a child. Just a family, not doing something special. This is a familiar scene. For the image before, maybe the person standing is also a father or a protector".

Theme: Mourning (figures 11, 12)

Fig. 11. *Mourning, first slide*

Most participants (apart from P5a, an expert in ancient Greek funerary objects) spent a few seconds observing this item before describing it (figure 11). Since many figures were involved, it was harder to understand what they were doing. However, almost all participants (9 out of 10) said that this is a funeral with different degrees of certainty (P3h & 6h were uncertain, while P1l,5a,7h,8l,9h10l were certain). P4: "We have a funeral ... for sure. If we assume that the 3 women are lying down and crying ... they mourn him. The others are men. We have a funeral". Only P2l did not mention a funeral but thought that this is an important event like the crowing of a king: "There are some men gathered. They do a ceremony because there is a boy in the middle. Should he be a prince who will become king? They do some ritual. He is the offspring of a good family". In observing the object, most participants expressed uncertainty although they suspected what was happening.

Fig. 12. *Mourning, second slide*

However, the next image left no doubts that there were funeral scenes (figure 12). All participants said that this is definitely a funeral scene. P1l had made observations about the posture of the figures in the two images and found similarities: "Again, here there are figures in despair that hold their faces. In the first image, the dead is in a bed, while in the second he is in a coffin". P5a connects to today's funerary practices: "It still continues to be done today. They place the body in a place for people to see". Similarly, P8l mentioned: "A funeral. Above him are the people, and they mourn. Corresponding scene, but in another era. They are essentially the same customs and traditions". P6h observed differences in the behavior of men and women, which, although identical in the ancient images, were not previously noticed: "Also a funeral. It could be from many parts of the world. Women are next to the coffin, and the men are behind. They are separated. Men seem silent while women are crying. There are different expressions. They are standing." Although the majority of participants had correctly identified the funeral scene by looking at the ancient item alone, the second image allowed them to confirm their hypothesis and view more details on the ancient object. The contemporary photo functioned as a confirmation, and most participants returned to the deeper observation of the ancient object. Realizations of past and present connections and new questions emerged, like the role of men and women.

Theme: At the cemetery (figures 13, 14)

Fig. 13. *At the cemetery, first slide*

This image (figure 13) was the most confusing of all, since participants could not understand what they saw, apart from P5a, who is an expert in ancient Greek funerary objects and said: "Another funerary tool. It is a woman that goes to the grave to pay respects to the dead". Thus, participants P2l,4l,9h,10l saw that the person was holding something, but they could not say more apart from that. P2l tried to make a guess, which was wrong: "A woman must have embroidered something like a scarf or shawl, and she hangs it somewhere. Maybe give it somewhere". The remaining participants (P1l,3h,6h,7h,8l) described a shrine or a temple and the person offering something closer to the correct interpretation of the image. However, they were all very uncertain about their statements. P1l, although wrongly identifies a man, described with uncertainty: "A man holding something like sheaves..is this an altar? Does he make a sacrifice on an altar? He leaves some things."

Fig. 14. *At the cemetery, second slide*

Clearly, the presentation of the next image (figure 14) helped most participants understand the scene in the ancient item. P3h: "It is a grave! They are in a cemetery in both photos. I do not remember burial traditions in ancient Greece, but I think it is a cemetery." P5a connects the past with today's reality and says: "We do the same. We go each year to our dead to give our respects". P10l stated: "A! It was probably .... a woman in front of the grave of a loved one. Maybe she is reading a prayer. A memorial perhaps? I cannot understand what the girl is holding in her hands (referring to the previous photo), but it is a similar scene where she has gone to the grave of one of a loved one to mourn. Both images have flowers. In front of them are tombs." Signs of constructivist processes are present again since participants connect the past and the present, show surprise and emotional engagement, connect with personal experiences, and show cultural understanding.

When asked to provide any final comments, participants made different comments. In particular, P1l and 7h discussed how the contemporary images provided context for interpreting the ancient ones. P1l went a step further and explained how such an approach could also be applied to other forms of art, not only ancient ones: "To see (images from) contemporary times and because we are used to seeing images from today's world, help us to have a context and understand what ancient people wanted to portray. Through contemporary photographs, I managed to understand what the initial images showed. This could be a proposal for improving the way we view works of art in museums. To understand better what they show. The contemporary framework assists the understanding of these items".

P2l,6h,8l,9h explained how this sequencing of images allowed them to connect the past and the present and see how lasting certain phenomena might be. P2l: "Some customs that existed from ancient times are preserved until now, such as the bride's decoration, dolls and tombstones".

P3h and 10l said that these images allowed them to observe aspects of ancient daily life. Especially as P3h mentioned: "Images from daily life. Things we are not used to seeing in ancient art. We are used to seeing heroes, warriors, gods…these are stereotypes we have about ancient Greek art. However, here we see common people's lives. It is mostly women. We are not used to seeing children and especially young girls".

Finally, P4l and 5a focused on women and noticed that these images showed women in different aspects of life. P4l has good knowledge of traditional life and customs since she comes from a small village on a Greek island, where many of these traditions remain. She showed high confidence in understanding the ancient images and applied knowledge from her life in the village. She concluded: "The female presence prevails in the images and in terms of the depictions in the objects and the photographs. It may show women to be in very important moments of their lives and important rituals of life, but also tasks such as water bringing and wool handling". Similarly, P5a, an archaeologist, said: "Most of these activities are done by women. They care for the children, the dead, they mourn, and they preserve the memories of the family. What happened in the classical Greek past still happens today. Possibly more in the East than in Western societies, but still women maintain this."

V. DISCUSSION

Based on the study results participants showed clear signs of meaning-making once they saw the ancient items together with the modern photos. More specifically, the ancient items made participants uncertain about what they saw (P1l, P8l, P10l). On many occasions, participants said they were unsure what they saw. Participants almost always used the modern image that followed the ancient one to confirm a hypothesis they had formed previously (P1l, P3h, P6h, P7h, P8l, P9h) or to realize what the ancient item showed (P1l, P3h, P6h, P8l, P9h, P10l). Participants, like P7h explicitly stated that seeing archaeological items out of context made it very hard to understand how to conclude. However, when participants saw the relevant photo, some were initially surprised (P3h, P8l) but could then understand the previous image. Moreover, participants could make connections to their prior knowledge (P1l, P3h, P5a, P7h, P9h, P10l) and their personal experiences (P5a), implying the construction of meaning. Concerning Soren's classification, again, participants were able to have unexpected emotional experiences (P2l), had the opportunity to focus on natural objects (P3h), understand how ancient societies function (P9h) and finally make connections between the past and the present (P2l, P4l, P5a, P6h, P7h, P8l, P9h, P10l) and realize that there are many similarities between ancient societies and today's world (P6h, P8l, P10l). Fig. 15 shows some indicative comments of participants. All participants were more or less familiar with ancient Greek art due to origin, studies or both. However, it was not easy even for them to understand ancient objects when they stood alone. The second images provided the necessary context and decreased uncertainty. All participants always went back to rethink the ancient object once the contemporary image was shown, although they were not asked to. The information gap and the uncertainty people experience needs to be resolved, and this is probably why people used the contemporary images as tools to understand the ancient ones. The contemporary photos alone, without any further explanation, were adequate in triggering reflection and enhancing the construction of meaning.

VI. CONCLUSIONS

The present study showed that it is hard even for experts to understand what items convey when not in context. As participants stated, detecting the details and understanding what they show is not easy. However, in most cases, the contemporary photo next to the ancient item was adequate to make people immediately realize what they saw. In addition, the photos not only function as interpretation aids but also allow participants to make multiple connections between past and present, across societies and cultures, between current and prior knowledge, and permit connections to personal experience. All these elements indicate critical constructivist approaches taking place when people are presented with the two images and meaning-making processes.

One participant (P1l) went beyond the use of contemporary photos to explain ancient items in archeological museums and suggested using photos in other types of museums, like art galleries. We find this suggestion worth studying further, since all types of art go through interpretation processes.

From the current study, we observed that photos of contemporary life are essential interpretation elements that assist meaning-making in museums since they allow people to make connections between museum items with familiar situations from current societies. However, it is important to note that all the selected archaeological items showed activities still performed today in many societies, and participants were more or less familiar with them. Thus, when they saw the contemporary photo showing the same activity, they easily understood what was depicted on the ancient item. It is unclear how photos would work for practices that are not performed today. The issue of finding alternative interpretation strategies and methodologies in museums remains a challenge. The present work proposed one possibility that works well under certain circumstances. Future work should also focus on different populations, like children, the elderly, etc., to further study the interpretation effect of photographs in museums.

In the present work, we only showed participants 7 sets of images in an attempt to reduce cognitive overload and avoid fatigue. In a museum, fatigue is a common phenomenon. In using photos as part of applications for museum use, we need to consider fatigue issues. For this reason, carefully designed museum experiences should find the balance between the material presented to the visitors and possible fatigue. Based on the "7plus or minus 2" rule, we suggest using a limited number of photos in museum applications. Thus, the material presented to the user through contemporary technology, which could incorporate everyday photos for further enhancing meaning-making, should be carefully selected and kept in low numbers. In other words, an app can choose to focus on 5 to 9 important objects and provide enhanced material, including everyday photos. The museums as physical spaces already contain a plethora of stimuli and technology wishing to assist museum visits should always consider issues of museum fatigue.

As seen in the introductory sections, museums use photos in different ways. One of the most popular uses is the exploitation of photos in social media to promote the museum and the exhibitions. Social sciences have also used photos to study visitor needs and understand how people make meaning and engage with the museum content. Fewer studies use photos to provide additional context. Within those, the present work directly looks into the processes of meaning construction by the visitors and possibly the only one that connects archaeological items with everyday photos. Confirming previous studies **[40]**, the present work also revealed the power of photos to assist people in understanding historical phenomena. The present work also tested the power of a single image with objects from a single domain (i.e. ancient Greek). Again, the presentation of one

image was not adequate even for people with special knowledge to understand fully, as also seen in Docket et al. **[41]** who also suggest the use of two or more similar photos together. Moving beyond Docket et al. **[41]**, we showed how only two images of similar themes can function well in providing the necessary context for comprehension and reflection. As past research has also shown **[42]**, keeping the images' theme area consistent is crucial, which was also applied in the present work. Thus, the current research successfully combined elements from previous works **[40, 41, 42]** and studied all the elements together, showing how the importance of photos in understanding cultural heritage and reflecting on the past. Finally, we can further confirm the findings of past studies **[43]** showing that photos have indeed the potential to function as necessary meaning construction tools, and they form meaningful artefacts that can enhance museum experiences.

The sample of the present work was limited, and since only university students participated, the results cannot be generalized. Thus, the present work only provides indications that contemporary photos could be beneficial when included in narrations regarding historical objects when this is possible (when there are relevant photos available). In order to further improve the content provided to museum visitors by cultural technologies, further research is needed. Advanced cultural heritage technologies can easily incorporate different visual aids to accompany narratives and provide an experience that allows visitors to make easy connections between the past and present, finding similarities to her life and overall assisting reflection processes.

In our future work, we will compare cultural technologies that include contemporary photos in the narratives of historical objects and ones that do not and will study visitors' interpretation strategies and meaning-making processes.

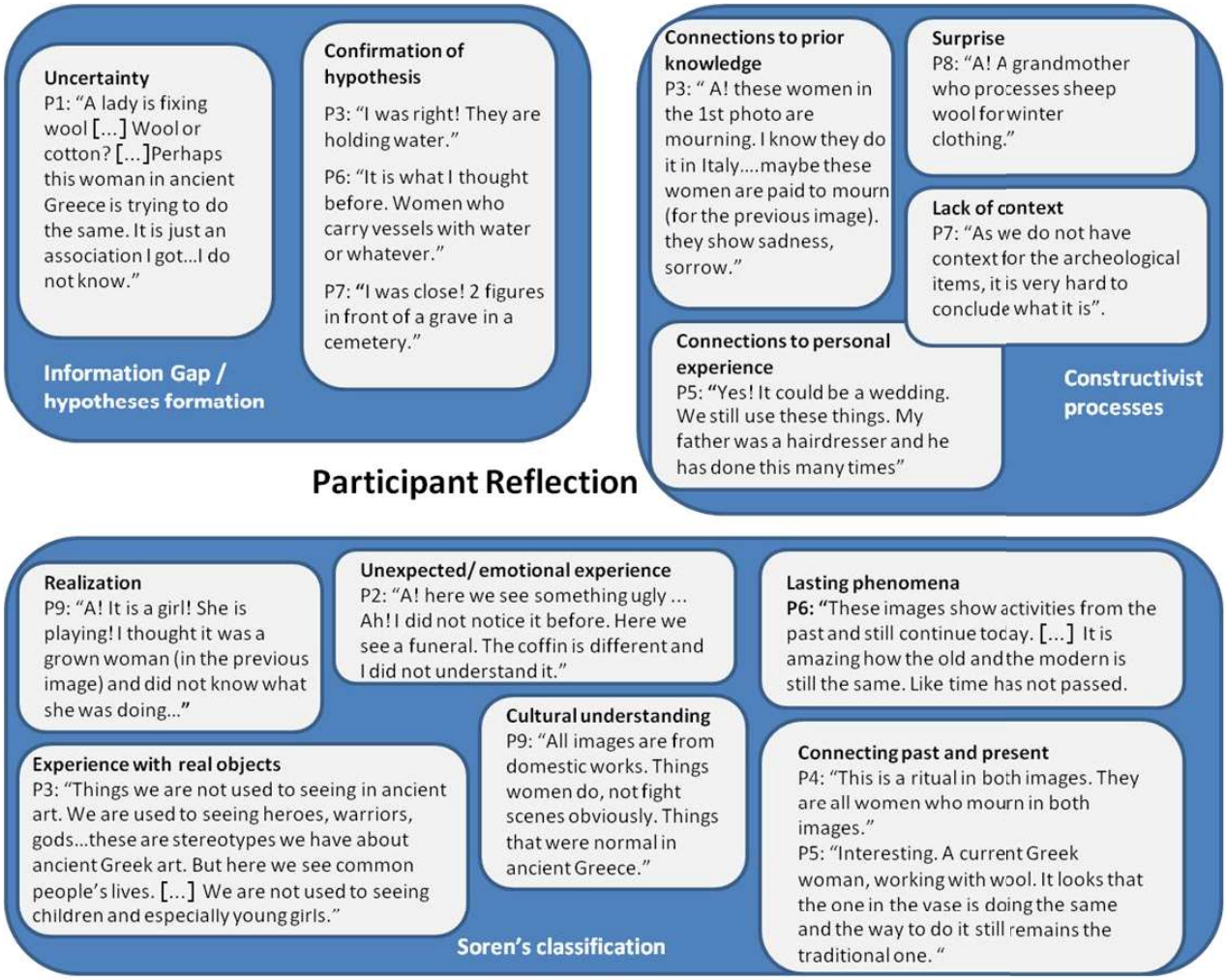

Fig. 15. Indicative participant comments and reflections

VII. Appendix A

Table 1 shows all the images used in the study with their licenses.

Table 1.Images used in the study with the licenses.

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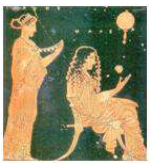	https://www.worldhistory.org/image/13701/greek-vase-depicting-wedding-preparations/ Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0)
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VIII. References

1. Lending, M. Landscape versus Museum: JC Dahl and the Preservation of Norwegian Burial Mounds. *Future Anterior* 2009, *6(1),* xi-17. https://muse.jhu.edu/article/364594
2. Lending, M. Negotiating absence: Bernard Tschumi's new Acropolis Museum in Athens. *The Journal of Architecture* 2018, *23(5),* 797-819. https://doi.org/10.1080/13602365.2018.1495909
3. Duffy, T. M.; Jonassen, D. H. *Constructivism and the technology of instruction: A conversation.* Routledge: New York, USA, 2013. https://doi.org/10.4324/9780203461976
4. Ellis, R.' Without decontextualisation': the Stanley Royd Museum and the progressive history of mental health care. *History of Psychiatry* 2015, *26(3),* 332-347. https://journals.sagepub.com/doi/10.1177/0957154X14562747
5. Gheorghiu, D.; Ştefan, L. A fractal augmentation of the archaeological record: the time maps project. In *Augmented Reality Art,* 2nd ed; Geroimenko, V., Ed.; Springer, Cham, 2018; pp. 297-316. https://doi.org/10.1007/978-3-319-69932-5_16
6. Montusiewicz, J.; Czyż, Z.; Kayumov, R. Selected methods of making three-dimensional virtual models of museum ceramic objects. *Applied Computer Science* 2015, *11(1),* 51-65. https://www.infona.pl//resource/bwmeta1.element.baztech-3af193c0-5d39-4208-a357-64c9de212251
7. Kamcke, C.; Hutterer, R. History of dioramas. In *Natural history dioramas;* Tunnicliffe, S., Scheersoi, A. Eds.;. Springer: Dordrecht, Netherlands, 2015; pp. 7-21. https://doi.org/10.1007/978-94-017-9496-1_2
8. Serrell, B. *Exhibit labels: An interpretive approach*. Rowman & Littlefield: New York, USA, 2015.

9. Antoniou, A.; Lepouras, G.; Kastritsis, A.; Diakoumakos, J.; Aggelakos, Y.; Platis, N. " Take me Home": AR to Connect Exhibits to Excavation Sites. Proceedings of AVI²CH@ AVI, Salerno, Italy, September-October 2020.
10. McMahon, M. Social constructivism and the World Wide Web-A paradigm for learning. Proceedings of the ASCILITE conference, Perth, Australia, December 1997.
11. Di Vesta, F. J. The cognitive movement and education. *Historical foundations of educational psychology* 1987, 203 - 233. https://doi.org/10.1007/978-1-4899-3620-2_11
12. Hein, G. E. The constructivist museum. *Journal of Education in Museums* 1995*, 16(1),* 21-23.
13. Hellin-Hobbs, Y. The constructivist museum and the web. Proceedings of the Electronic Visualisation and the Arts (EVA), London, UK, July 2010. https://doi.org/10.14236/ewic/EVA2010.13
14. Fosnot, C. T. *Constructivism: Theory, perspectives, and practice,* 2nd ed.*;* Teachers College Press: New York, USA, 2013.
15. Sandifer, C. Technological novelty and open-endedness: Two characteristics of interactive exhibits that contribute to the holding of visitor attention in a science museum. *Journal of Research in Science Teaching* 2003*, 40(2),* 121-137. https://doi.org/10.1002/tea.10068
16. Bitgood, S. *An attention-value model of museum visitors.* Center for Advancement of Informal Science Education: Washington, DC, USA, 2010.
17. Bitgood, S. Attention and value: Keys to understanding museum visitors. Routledge: New York, USA, 2016.
18. Antoniou, A.; O'Brien, J.; Bardon, T.; Barnes, A.; Virk, D. Micro-augmentations: situated calibration of a novel non-tactile, peripheral museum technology. Proceedings of the 19th Panhellenic Conference on Informatics, Athens, Greece, October 2015. https://doi.org/10.1145/2801948.2801959
19. Alachouzakis, K.; Veneris, N. D.; Kavvadias, S.; Antoniou, A.; Lepouras, G. A study of micro-augmentations: personality, gender, emotions and effects on attention and brain waves. Proceedings of the 22nd Pan-Hellenic Conference on Informatics, Athens, Greece, November 2018. https://doi.org/10.1145/3291533.3291582
20. Edwards, E.; Lien, S. Museums and the Work of Photographs. In *Uncertain images: museums and the work of photographs;* Edwards, E.; Lien, S. Eds.; Ashgate: Farnham, UK, 2016; pp. 3-20.
21. Edwards, E.; Mead, M. Absent histories and absent images: Photographs, museums and the colonial past. *Museum and Society* 2013*, 11(1),* 19-38. https://journals.le.ac.uk/ojs1/index.php/mas/article/view/220
22. Edwards, E.; Lien, S. *Uncertain images: Museums and the work of photographs*. Ashgate Publishing: Farnham , UK, 2016.
23. Edwards, E.; Morton, C. *Photographs, museums, collections: between art and Information*. Bloomsbury Publishing: London, UK, 2015. https://doi.org/10.14434/mar.v10i1.20591
24. Edwards, E. *Raw histories: photographs, anthropology and museums*. Routledge: London, 2021.
25. Crane, S. A. Photographs at/of/and Museums. In *The Handbook of Photography Studies;* Pasternak, G, Ed; Routledge, 2020 pp. 493-512.
26. Weilenmann, A.; Hillman, T.; Jungselius, B. Instagram at the museum: communicating the museum experience through social photo sharing. Proceedings of the SIGCHI conference on human factors in computing systems, Paris, France, April 2013. https://doi.org/10.1145/2470654.2466243
27. Villaespesa, E.; Wowkowych, S. Ephemeral storytelling with social media: Snapchat and Instagram stories at the Brooklyn Museum. *Social Media+ Society* 2020*, 6(1),* 2056305119898776. https://doi.org/10.1177/2056305119898
28. Poulsen, S. V. Becoming a semiotic technology–a historical study of Instagram's tools for making and sharing photos and videos. *Internet Histories* 2018 *2(1-2),* 121-139. https://doi.org/10.1080/24701475.2018.1459350
29. Fors, V. Sensory experiences of digital photo-sharing—"mundane frictions" and emerging learning strategies. *Journal of Aesthetics & Culture* 2015*, 7(1),* 28237. https://doi.org/10.3402/jac.v7.28237
30. Steier, R.; Pierroux, P.; Krange, I. Embodied interpretation: Gesture, social interaction, and meaning making in a national art museum. *Learning, Culture and Social Interaction* 2015*, 7,* 28-42. https://doi.org/10.1016/j.lcsi.2015.05.002
31. Pauwels, L. Photography in the Social and Behavioral Sciences: Intersections, Research Modes, and Prospects. In *The Handbook of Photography Studies*; Pasternak, G. Ed.; Routledge, 2020, pp. 122-138.
32. Gube, J. Photo-eliciting technique as an integrated meaning-making practice: An introspective look at diversity, identities, and voice-giving. *Visual Studies* 2021*, 37(1-2),* 116-127. https://doi.org/10.1080/1472586X.2020.1854053
33. Insulander, E.; Selander, S. Designs for learning in museum contexts. *Designs for Learning* 2009*, 2(2),* 8-20. https://www.diva-portal.org/smash/get/diva2:390826/FULLTEXT01.pdf
34. Marcus, A. S.; Levine, T. H. Knight at the museum: Learning history with museums. *The Social Studies* 2011*, 102(3),* 104-109. https://doi.org/10.1080/00377996.2010.509374
35. Britsch, S. Photo-booklets for English language learning: Incorporating visual communication into early childhood teacher preparation. *Early Childhood Education Journal* 2010*, 38*, 171-177. https://doi.org/10.1007/s10643-010-0412-2
36. Markham, K. Two-dimensional engagements: photography, empathy and interpretation at District Six Museum. *International Journal of Heritage Studies* 2017*, 25(1*), 21-42. https://doi.org/10.1080/13527258.2017.1378900
37. Drew, S.; Guillemin, M. From photographs to findings: Visual meaning-making and interpretive engagement in the analysis of participant-generated images. *Visual Studies* 2014, *29(1),* 54-67. https://doi.org/10.1080/1472586X.2014.862994
38. Loeffler, T. A. A photo elicitation study of the meanings of outdoor adventure experiences. *Journal of leisure research* 2004, *36(4),* 536-556. https://doi.org/10.1080/00222216.2004.11950035
39. Gauthier, L.; Staszak, J. F. Framing Coloniality: Exotic Photographs in Swiss Albums, Museums, and Public Spaces (1870s–2010s). *Photography and Culture* 2015, *5(3),* 311-326. https://doi.org/10.2752/175145212X13415789393207
40. Tucker, J. Photography and the making of modern science. In *The Handbook of Photography Studies*; Pasternak, G. Ed.; Routledge, 2020, pp. 235-254.
41. Dockett, S.; Einarsdottir, J.; Perry, B. Photo elicitation: Reflecting on multiple sites of meaning. *International Journal of Early Years Education* 2017*, 25(3)*, 225-240. https://doi.org/10.1080/09669760.2017.1329713
42. Wright, D.; Sharpley, R. The photograph: Tourist responses to a visual interpretation of a disaster. *Tourism Recreation Research,* 2017*, 43(2),* 161-174. https://doi.org/10.1080/02508281.2017.1409921
43. Fawns, T. Cued recall: Using photo-elicitation to examine the distributed processes of remembering with photographs. *Memory Studies* 2022, 17506980211073093. https://doi.org/10.1177/17506980211073093
44. Kontiza, K.; Antoniou, A.; Daif, A.; Reboreda-Morillo, S.; Bassani, M.; González-Soutelo, S.; ... López-Nores, M. On

How Technology-Powered Storytelling Can Contribute to Cultural Heritage Sustainability across Multiple Venues—Evidence from the CrossCult H2020 Project. *Sustainability* 2020*, 12(4),* 1666-1692. https://doi.org/10.1080/24701475.2018.1459350

45. Wyman, B.; Forbes, J. ArtClix: The High Museum of Art's foray into mobile aps, image recognition, and visitor participation. Proceedings of MW2013: Museums and the Web 2013, Portland, USA, April 2013.
46. Liao, M. H. One photo, two stories: Chinese photos in British museums. *East Asian journal of popular culture* 2015*, 1(2),* 177-191. https://doi.org/10.1386/eapc.1.2.177_1
47. Papakostopoulos, V.; Vaptisma, A.; Nathanael, D. Narrative Structure of Museum Guided Tours. Proceedings of the 31st European Conference on Cognitive Ergonomics, Belfast, UK, September 2019. https://doi.org/10.1145/3335082.3335095
48. Paivio, A. Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology/Revue Canadienne de Psychologie* 1991*, 45(3),* 255-287. https://doi.org/10.1037/h0084295
49. Hargood, C.; Millard, D. E.; Weal, M. J. A semiotic approach for the generation of themed photo narratives. Proceedings of the 21st acm conference on hypertext and hypermedia, Toronto, Canada, June 2010. https://doi.org/10.1145/1810617.1810623
50. Sandelowski, M. Sample size in qualitative research. *Research in nursing & health* 1995, *18*(2), 179-183. https://doi.org/10.1002/nur.4770180211
51. Cid López, R. M. El género y los estudios históricos sobre las mujeres de la Antigüedad. Reflexiones sobre los usos y evolución de un concepto. *Revista de Historiografía* 2015, 25-49. https://e-revistas.uc3m.es/index.php/REVHISTO/article/view/2645
52. Morillo, S. R. La maternidad: de la infancia a la adolescencia en la Grecia antigua. In *Los trabajos de las mujeres en el mundo antiguo: cuidado y mantenimiento de la vida*; Delgado Hervas, A.; Picazo Gurina, M., Eds.; Institut Català d'Arqueologia Clàssica: Tarragona, Spain; 2016, pp. 119-128. https://dialnet.unirioja.es/servlet/articulo?codigo=5994834
53. Morillo, S. R. Chilhood and motherhood in Ancient Greece: an iconographic look. In *Motherhood and infancies in the Mediterranean in antiquity;* Cid Lopez, R.; Sanchez Romero, M., Ed.;, Oxbow Books: Oxford, UK, 2018, pp. 135-151.
54. Morillo, S. R. Dialogar con las divinidades en femenino: Espacios y ritos relacionados con la maternidad en la Antigüedad griega. In *Cartografías de género en las ciudades antiguas. Editorial Universidad de Granada;* Martine Lopez, C.; Ubric Rabaneda, P., Eds.; Universidad de Granada: Granada, Spain; 2017, pp. 181-206. https://dialnet.unirioja.es/servlet/articulo?codigo=6279598
55. Morillo, S. R. Emociones en femenino, de madres a hijas. El ejemplo de los rituales fúnebres en la Grecia antigua. In *Madres y familias en la Antigüedad: patrones femeninos en la transmisión de emociones y de patrimonio*; Cid Lopez, R.M.; Dominguez Arranz, M-A.; Saez, R.M.M., Eds.; Trea: Spain, 2021, pp. 21-38.
56. Miller, G. A. The magic number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review* 1956*, 63*, 91-97.
57. Soren, B. J. Museum experiences that change visitors. *Museum Management and Curatorship* 2009*, 24(3),* 233-251. https://doi.org/10.1080/09647770903073060
58. Antoniou, A.; Morillo, S. R.; Lepouras, G.; Diakoumakos, J.; Vassilakis, C.; Nores, M. L.; Jones, C. E. Bringing a peripheral, traditional venue to the digital era with targeted narratives. *Digital Applications in Archaeology and Cultural Heritage* 2019*, 14,* e00111. https://doi.org/10.1016/j.daach.2019.e00111
59. Poulopoulos, V.; Vassilakis, C.; Antoniou, A.; Lepouras, G.; Theodoropoulos, A.; Wallace, M. The Personality of the Influencers, the Characteristics of Qualitative Discussions and Their Analysis for Recommendations to Cultural Institutions. *Heritage* 2018*, 1(2),* 239-253. https://doi.org/10.3390/heritage1020016
60. Poulopoulos, V.; Vassilakis, C.; Antoniou, A.; Lepouras, G.; Wallace, M. Personality Analysis of Social Media Influencers as a Tool for Cultural Institutions. Proceedings of the Euro-Mediterranean Conference, Nicosia, Cyprus, October 2018. https://doi.org/10.1007/978-3-030-01762-0_20
61. Gash, H. Constructing Constructivism. *Constructivist Foundations* 2014*, 9(3),* 302-310.

IX. AUTHORS

Angeliki Antoniou is an Assistant Professor in the Department of Archival, Library & Information Studies at the University of West Attica specializing in "Adaptive Educational Technologies in Cultural Information". She holds a PhD in Educational Technologies from the University of Peloponnese, Department of Computer Science and Technology.

Susana Reboreda Morillo is a tenured professor of History at the University of Vigo. She has a PhD in Ancient History since 1993. Her main lines of research refer to women in Greek Antiquity and Greek mythology, with special reference to the Homeric poems.

Eftychia Vraimaki is an Assistant Professor at the Department of Archival, Library & Information Studies and a member of the Information Management Laboratory of the University of West Attica. In 2010 she was awarded a PhD in Business Administration (Knowledge Management & Organizational Behavior) from the Department of Production & Management Engineering of the Democritus University of Thrace.

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Developing the infrastructure for managing institutional research archives

Anastasios Tsolakidis[1], Evangelia Triperina[1], Ioannis Triantafyllou[2], Christos Skourlas[1]

[1]University of West Attica Department of Informatics and Computer Engineering
[2]University of West Attica Department of Archival, Library and Information Studies
atsolakid@uniwa.gr [**ORCID**: 0000-0001-7364-4542], evatrip@uniwa.gr [**ORCID**: 0000-0003-4282-2259], triantafi@uniwa.gr [**ORCID**: 0000-0001-5273-0855], cskourlas@uniwa.gr [**ORCID**: 0000-0003-4464-5305]

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Abstract:

Purpose *- Capturing research in modern academic institutions is of vital importance. A robust approach to systematically harvest, host, and update a university-wide repository is not only beneficial for the academics within the HEI, but it can also boost and promote the visibility of the University.*

Design/methodology/approach *- Although many decentralised approaches offer the possibility to showcase an individual's research, the vast and disparate sources cannot facilitate an institutional repository. Since research constitutes one of the main aims of a university, we follow a solution that records the whole research that occurs within an institution, which is VIVO. In this paper, we present the adaptation of VIVO by a Greek University, namely, the University of West Attica. In our approach, we have merged the existing systems and harvested research-related information from different sources on the web.*

Findings *- The proposed solution serves as an academic research repository. It provides consistency over the presented research outputs, making the research of the University wider visible.*

Originality/value *- The paper presents an ontology-based system for documenting the undertaken research within an institution. Moreover, it allows the personalisation of the ontology, thus making it possible to customise the repository to fit an institution's needs, the web interface, therefore presenting the perceived significant components for the University, and the information visualisation.*

Index Terms — institutional repository, linked open data, ontology, research archives, research management, semantic web.

I. Introduction

Nowadays, the highly competitive academic environment dictates the need to record, present and assess the activities and collaborations that take place in universities. Since academic institutions have manifold roles involving research, education, innovation, and industry collaborations, this information must be systematically captured in an institutional repository. Moreover, it is vital to examine the links between research and education and to inspect how they affect each other and to what degree. The conducted research, its outcomes and the involved people, the educational activities, collaboration and their results, and the collaboration within academia and with organisations correspond to valuable information for an institution and can contribute to quality assurance, strategic planning, dissemination of educational and research outputs and deduction of meaningful results. Apart from facilitating the various academic and managerial processes, this information can also enable academic networking. We present a system that aggregates research and education records and services. Our system aims to offer a solution for managing and manipulating academic information for our institution's and its departments' evaluation and quality assurance.

Our approach builds upon the VIVO ontology and introduces an elaborate research management information system called IREMA (Institutional REsearch MAnagement) **[1]**. Our system uses the sharable and reusable linked data produced by the VIVO semantic web application and implements web services. As a direct consequence, our solution is both sustainable and extendable. Within IREMA we have implemented and profiled VIVO for our academic institution, the University of West Attica, Greece. We have adopted the VIVO-ISF ontology and extended it to meet our University's requirements, which led to the creation of the AcademIS ontology **[2]**. All the information of our system is stored in the VIVO instance, and the web services are built upon VIVO to access the data and communicate the information to the other employed systems. VIVO also covers the academic networking requirements of the institution, while IREMA retrieves the institutional data stored in VIVO by executing SPARQL queries in the instance of the semantic web application, the outputs of which are acquired in .json format. IREMA then reuses the information

of VIVO, applies metrics to the data and visualises the results.

Moreover, based on the data retrieved by the before-mentioned installation, we implement a decision support mechanism aided by visualising the data. IREMA provides efficiency measure techniques, data mining methods (cluster analysis, association rules and Bayesian networks), and social network analysis (including community detection, identification of research hubs and discovery of the most important researchers based on specific characteristics). The motivation for developing the IREMA system and linking it to our VIVO instance is integrating the academic services in our institution to satisfy the various and diverse needs that exist in the academic setting by a single integrated information system. Therefore, it is possible to explore all the activities and collaborations in an academic institution and have insights about future collaborations. In this paper, there is a thorough analysis of the way we use the semantic application VIVO and its importance for our approach. Furthermore, we present the exploitation and the extension of the underlying VIVO-ISF ontology, which assist us in accumulating academic information, structuring and analysing it. Our system supports the further presentation of the data, including visualisations and visual analytics, IREMA **[1]**, **[3]**, which is also outlined.

The paper is structured as follows: the first section is the introduction, whereas the second section corresponds to the background information. Section 3 outlines the basic concepts of our research management infrastructure and the presentation of VIVO adoption in our academic institution, including the implementation of VIVO-ISF ontology and its extension. The fourth section demonstrates how the proposed approach can be used to guide academic decisions. Finally, in section 5, there is the conclusion and the future work.

II. Background

A. Capturing research

Universities have become a major source of novel knowledge and research due to their involvement in research activities **[4]**. Universities and research institutions must capture and disseminate research and research outputs, which are needed from various user groups, including scientists, policymakers, policy researchers, industry, and media **[5]** and should keep up with the emerging requirements **[6]**. Academic institutions utilise information systems dedicated to research to depict the research activities. A research information system is "any informational tool dedicated to providing access to and disseminating research information" **[7]**. A research management system is a subcategory of a research information system, which supports workflow for the entire research procedure **[8]**, and IREMA constitutes such a system.

B. Research Information Systems and data models

More and more academic institutions have made use of Research Information Management Systems (RIMS) and Current Research Information Systems (CRIS) **[9-13]**. According to the literature, CRISs have been implemented in many universities autonomously or integrated **[14]** with other web services. CRISs have been enhanced with Linked data and semantic web technologies **[15], [16],** blockchain technology **[17]**, visualisations **[15]** and other technologies to better support the hosting and the presentation of the conducted research. The imperative need for CRIS in the academic setting is underlined by creating and disseminating intelligent systems for training stakeholders to use the research information systems effectively and efficiently **[18]**. Other approaches have examined RIS over their ergonomic evaluation **[19]**. CRIS systems can be categorised as institutional, regional, national, or international.

Among the most used data models for capturing information about the conducted research is the CERIF (Common European Research Information Format), which is a standard for managing and exchanging research data **[20]**, **[21], [22]**. VIVO is an ontology that offers a unified, formal, and explicit specification, which depicts data about researchers, institutions, activities, outputs, and related relationships [23].

III. Research Management Infrastructure And Institutional Repository

The research management infrastructure includes the facilitation of academic records, and the analysis of the research information employing visualisations and their interconnections. The University's academic records are stored in VIVO, which serves as an academic repository, while the IREMA system analyses the involved information. The infrastructure includes functionalities such as academic archiving and networking, quality assurance, visualisations of the data based on specific metrics and decision support aided by visualisations. It also provides efficiency measure techniques, data mining methods and social network analysis. To further process the VIVO instance's data, we have developed a connection between VIVO and IREMA based on VIVO-ISF ontology. It is also compatible with the ontology we developed, the AcademIS ontology **[8], [9]**, which is based on the VIVO-ISF ontology. All the components and functionalities of our system (**Fig. 1**) will be thoroughly described in the subsequent sections, as well as how the components are linked to each other, how they interact, and how the institutional data from VIVO are transferred to IREMA.

A. VIVO

VIVO **[24, 25]** is the backbone of our system since it is the basis of the IREMA web services and facilitates academic networking needs. Within our VIVO instance, we store information related to research, education, and the quality of both research and education. Furthermore, we explore and accumulate information about how education and research interrelate within an academic institution. To accumulate all the previously mentioned academic

information, we have developed the AcademIS ontology.

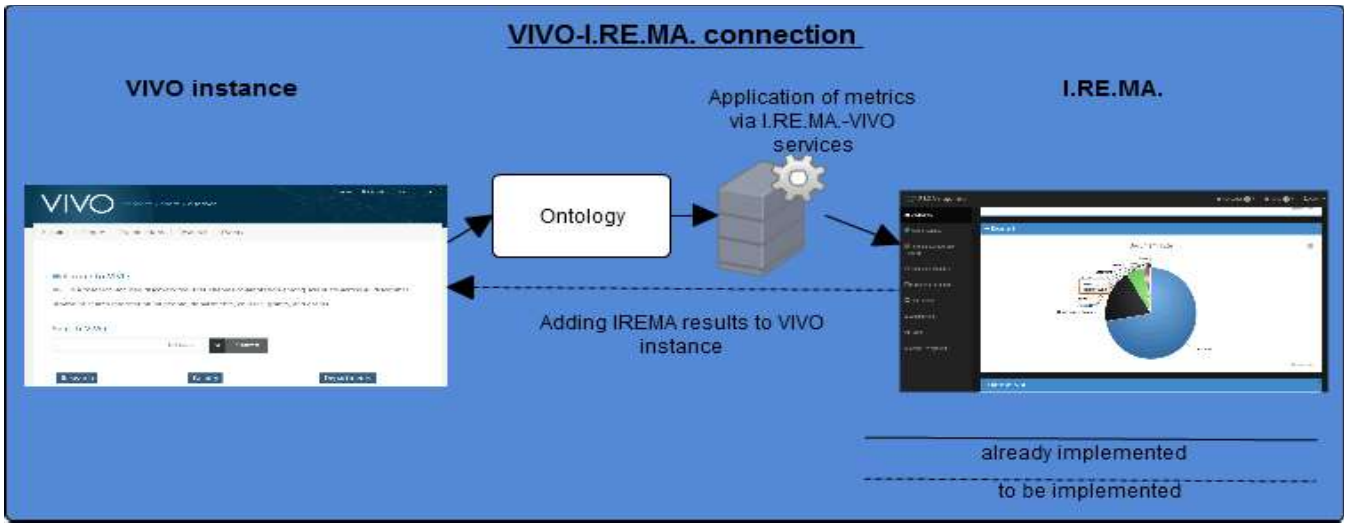

Fig. 1. *The VIVO-IREMA research management infrastructure*

In this section, we will refer to VIVO-ISF ontology and present thoroughly the AcademIS extension and the VIVO instance of the University of West Attica.

VIVO-ISF ontology models information about research and education in HEIs. However, our system needed more details about education, the points in which education and research correlate and the quality management of academic endeavor. Consequently, we have used the VIVO-ISF ontology, which covers most of our requirements and has extended it to comply with our additional needs. To maintain the interoperability of the VIVO ontology **[10]**, we designed the additions to be as general as possible so that the AcademIS could be applicable to a broad range of educational institutions.

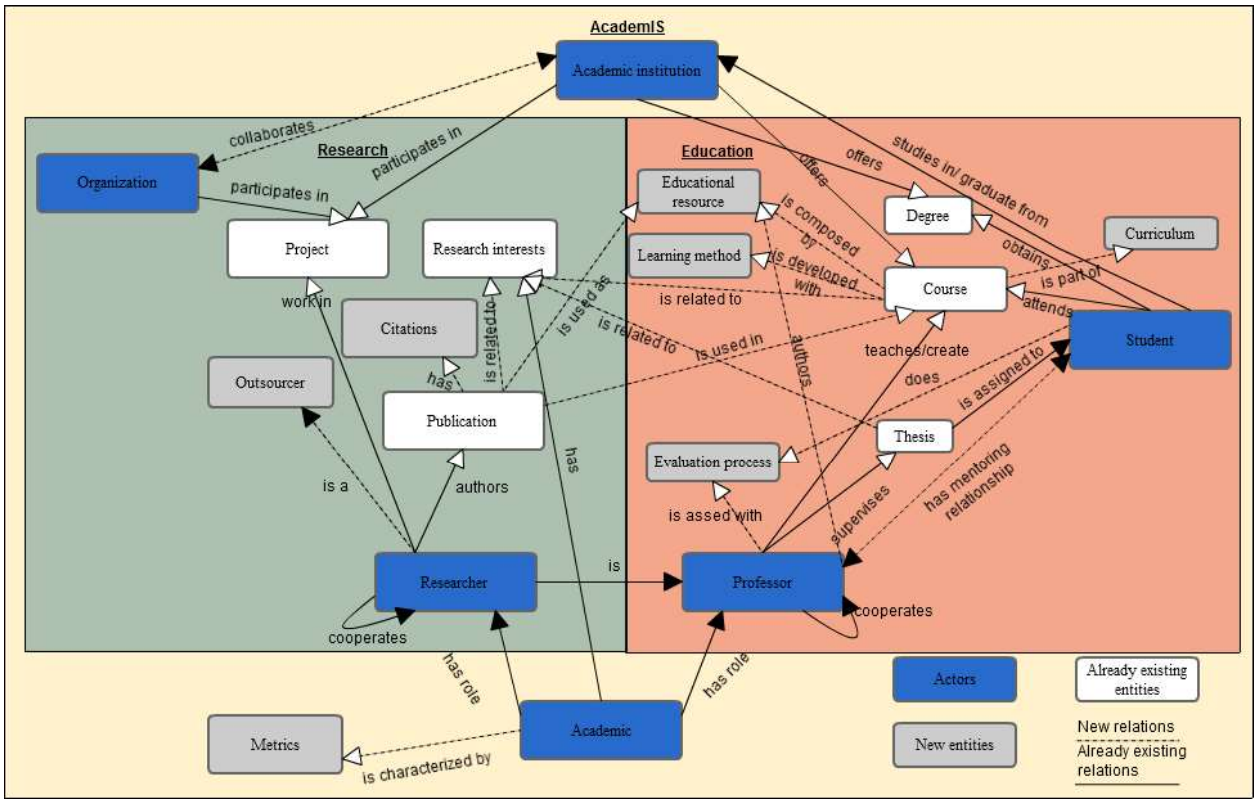

Fig. 2. *AcademIS ontology*

The AcademIS ontology is presented in **Fig. 2**. Our purpose for developing the AcademIS ontology is to provide a knowledge model of the academic domain. The AcademIS (Academic Information System) ontology is used as a basis for facilitating academic records management in our VIVO instance and the IREMA system.

The ontology has been implemented in OWL 2, in Protégé and then added in the VIVO University of West Attica instance. The domain of AcademIS is the academic activities and collaborations in HEIs. It encapsulates the research and education of an academic institution. The intended end users are the faculty, including the professors and the researchers, the policymakers of academic institutions, the quality assurance unit, and the VIVO and IREMA users of the HEI. The main indented uses of our ontology are the facilitation of research and education management, the quality management of an academic institution and academic data analysis via visualisations.

The AcademIS ontology introduces several new terms and relationships regarding academic institutions, the most important of which will be presented in this section. Regarding research quality, AcademIS ontology only adds information about citations of publications. AcademIS includes information about the educational process to measure the quality of education. The outsourcer entity regarding the research has been added, corresponding to the external research collaborator. In the context of education, we have appended the learning methods and the educational resources. The AcademIS ontology also measures how the research results and resources are used in or inspire the creation of educational resources and how the educational resources and outputs (such as thesis, etc.) are used in or inspire further development in research. The quality management aspects of the AcademIS are citation count, evaluation, etc.

B. VIVO instance – the case study of UNIWA

Initially, we implemented an instance of the VIVO for the Department of Informatics of the University of West Attica, and then we extended it at a larger scale. It now covers the whole academic institution. The VIVO instance of our academic institution includes research information, such as publications and research projects, as well as educational information, like courses. It uses the additional fields of AcademIS ontology by capturing learning outcomes, learning methods, educational resources, information about the academic institution's services and information about the interaction of education and research. It also provides quality management information.

The information was aggregated to our research repository from various sources, including institutional data (university records about research and education that happens in the premises of the University of West Attica in relational databases and other digital formats, etc.) and data from large online publications databases (Scopus, dblp). The VIVO instance was filled by employing the harvesting and ingestion options offered by VIVO. The data has been incorporated into the system, allowing users to edit, delete, or add information. To elaborate, the individuals curated the data to avoid invalid information and duplicate records to ensure the data's quality and integrity. Using the VIVO repository also enables the unification of all the academic information, increases its availability, and makes it available in Linked Data format **[11]**.

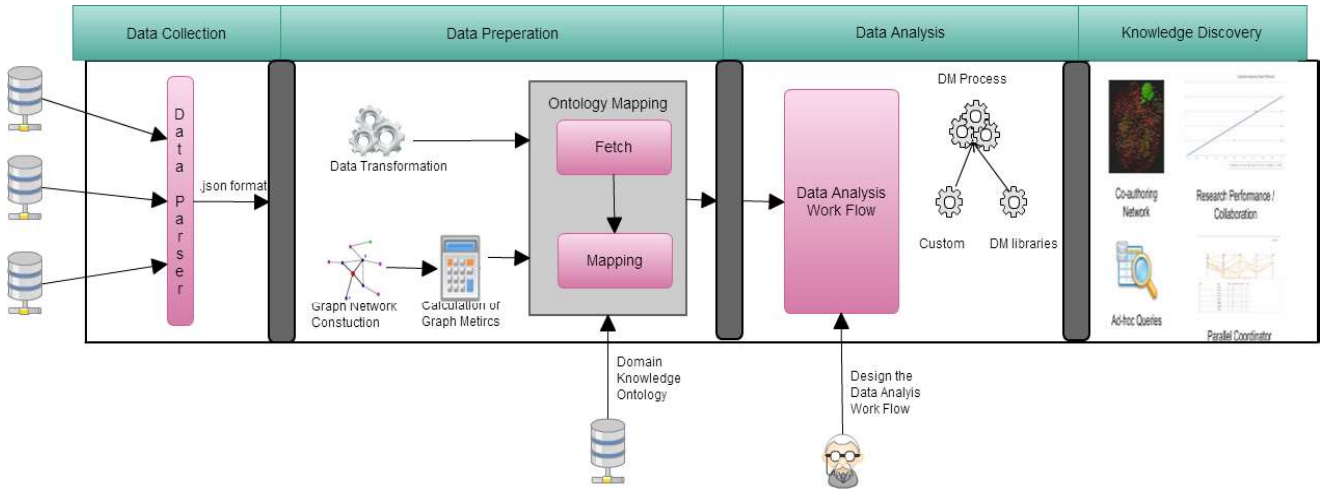

Fig. 3. *IREMA architecture*

C. IREMA - Institutional Research Management

IREMA stands for Institutional Research Management. The IREMA system collects data from multiple academic sources, mainly from the VIVO instance, followed by data transformation and ontology mapping using the domain ontology to prepare the data to be inputted into the system. The graph metrics are also calculated in that stage. The consequent step is the data analysis, while the final phase of the process is the knowledge discovery. To elaborate, the knowledge discovery is performed either with visualisation (co-authoring network, parallel coordinator, etc.), or with ad-hoc queries. In **Fig. 3**, we present the architecture of IREMA.

Apart from the process of our institutional data, we have implemented this process, which is applicable to other types of data that are available on the Internet (**Fig. 4**). For instance, it is possible to perform our interactive analysis on other VIVO instances, or even to use IREMA for social networks' analysis. It is also feasible to employ the IREMA

system in other domains by simply adjusting the ontology with the assistance of domain experts. Thus, IREMA can be utilised to carry out, for instance, environmental or financial analysis, depending on the input data and the underlying domain ontology.

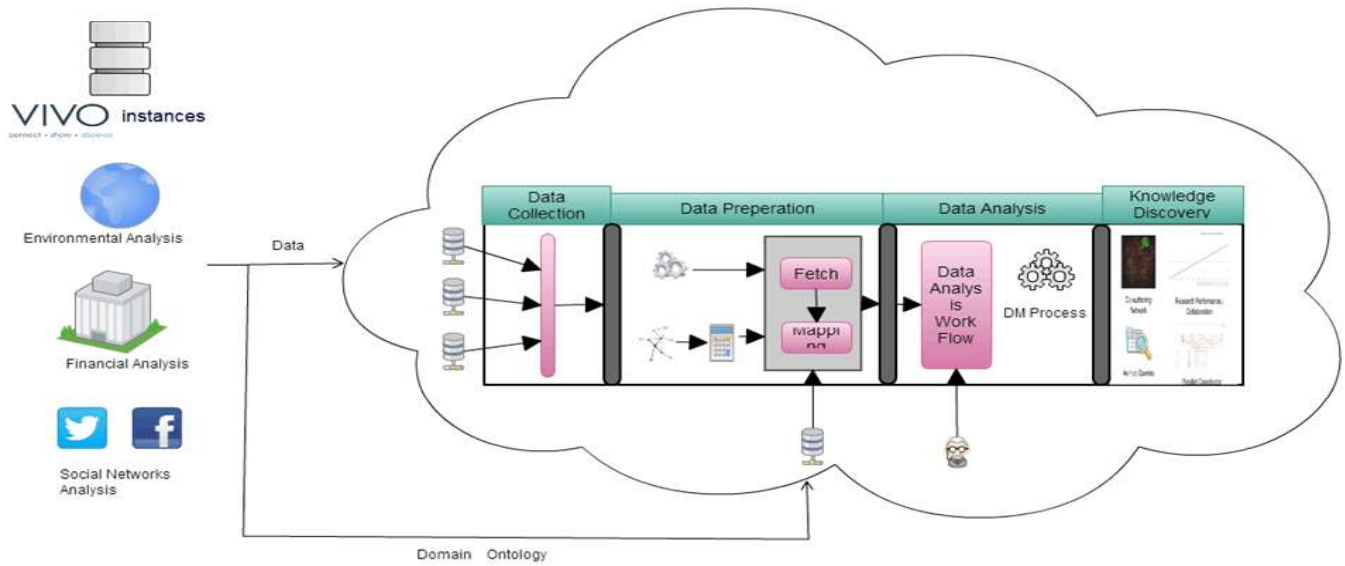

Fig. 4. *IREMA as a web service*

IREMA is a system that can be used to explore the co-authoring networks formed within an academic institution and gain insights into important scientific information. This system allows users to make better and more intuitive decisions by exploiting the information already in the VIVO repository. However, by applying metrics to the data, the information becomes more apparent and with the visualisations of the data, it is more efficiently perceived. Even large datasets can be explored easier and more interactively.

D. Features of the system

VIVO facilitated several functionalities, including academic networking and an institutional networking tool. Moreover, it has been employed during the data aggregation stage and as a management tool for academic information. In addition, our VIVO endpoint has also been employed to parse the academic information to the cooperating system, the IREMA. In this section, we will describe the architecture of our application, which consists of two main components, the VIVO-IREMA component, which includes all the data analysis methods and algorithms. All those methods are published using web services, and the clients consume (call) web services from the VIVO-IREMA. The layers of the VIVO-IREMA are the following:

i. Data collection and data cleansing: We use data from different data sources, for example, data from VIVO SPARQL endpoints or online publication databases, etc.
ii. Data transformation: During that process, a graph containing the academic researchers, based on the co-authorship of research papers, is created. In this stage, we calculate five (5) graph measures: degree centrality, closeness centrality, betweenness centrality, eigenvector and clustering co-efficient.
iii. Data Mining (DM): is used to extract hidden predictive information. The DM method falls into the categories of clustering, classification, and association analysis.
iv. Knowledge discovery via data visualisations: The proposed framework integrates interactive visual interfaces to support Knowledge Discovery (KD), thus providing the user with enhanced assistance throughout the decision-making (DM) process.

E. Presentation and visualisations of the data

The proposed framework supports the following visual representation techniques:

i. Co-authoring Graph is created based on the collaboration of faculty members in research papers.
ii. Efficiency Line is used to represent the correlation among the indicators.
iii. Parallel Coordinators is an interactive representation where the users can dynamically apply a set of criteria (dynamically) depending on their objectives.
iv. Map of Science, where each research area is represented in pie charts.

The visualisations are built based on specific metrics used to measure the research efficiency of academics and give insights into the trends regarding research activities and collaborations in the academic setting. In our application, we have implemented a graph analysis interface which calls web services from the VIVO-IREMA framework and displays the data in real-time using interactive graph networks. Moreover, we can make valuable deductions about the creation of research communities, the operation of

researchers as research hubs, the speed of the dissemination of information from an author to all the other authors in succession, the significance of an author in a network and the likelihood of an author and their connected authors to be a group. To examine the impact of collaboration patterns on the research activities of the faculty, we use the following network metrics. The graph density measures the connectivity among authors and their ability to collaborate. The average distance is the shortest path length between two connected nodes. The degree centrality is the number of arcs at each node and measures the 'activity' of the node. The betweenness centrality measures the ability of a node to connect nodes that do not have any direct connection. These nodes are called hubs because they can transfer information from one researcher to another.

The closeness centrality is defined as the inverted sum of the shortest distances between each node and every other node. It is interpreted as the ability to access information through the "grapevine" of network members. The eccentricity centrality of a node k is the largest geodesic distance from every other vertex. Therefore, it reflects how far each node is from every other node at most. The eigenvector centrality measures the importance of a node in a network. It assigns relative scores to all nodes in the network based on the principle that connections with high-scoring nodes contribute more to the score of the node in question than equal connections to low-scoring nodes. The clustering coefficient quantifies how close the node and its neighbours are to be a clique. It determines whether a network is a small-world and calculates and displays all nodes' clustering coefficients. The HITS calculates the "hubs-and-authorities" importance measures for each node. These measures are defined recursively as follows: the hub is the degree to which a node links to other important authorities, and authority is the degree to which important hubs point to a node.

F. Connecting VIVO & IREMA

IREMA is a web service that receives academic data from VIVO installations or other sources and returns interactive visualisations and efficiency metrics. For the IREMA process to occur, the VIVO data must be imported or connected to IREMA. The connection can be described as follows: the data from VIVO are processed through IREMA with the aid of the ontology. Then metrics are applied to the data. Finally, the interface of IREMA presents the data in the form of visualisations. The clients can interact with the data collection layer to i) send the appropriate data, ii) call specific data analysis/preparation services, and iii) call specific data visualisations.

IV. Guiding Academic Decisions

IREMA – VIVO infrastructure is utilised to guide academic decisions. The system can produce meaningful insights about academic activity and collaborations and assist in decision-making about research. Its interface is user-friendly and intuitive. The visualisations utilise the user's perception abilities and make the process of exploring the results easier. In this section, we will present an example of the way the system can assist the process of institutional decision-making by indicating a significant question about academic activity that can be answered by our system, as well as the outline of the process that our system is following to answer those questions. The user wants to find the most qualified researchers and explore if they could collaborate. To find the most active researchers using the IREMA system, we would follow the following actions: to find the most connective researchers, to examine whether they have any common research area and which is the development of their common area due to the time.

V. Conclusion

Our approach captures the academic activities, co-operations, and complex connections generated in academia. Furthermore, it analyses academic information using metrics and employs interactive visualisations to give answers to significant questions related to institutional management. The approach we propose can be applied in various cases, the most significant of which is to any VIVO instance. Our future work comprises the following steps. We prioritise making the connection between the IREMA and the VIVO bidirectional. To be more precise, we want to return the results from IREMA to our VIVO instance and comprehensively present them. We have already examined and appended to our ontology all the required fields. Another aspect is the integration of educational activities and collaborations, as well as the connections between education and research in the IREMA. We have already enriched our ontology with the required education fields and those that reveal connections between education and research. We have also accumulated the educational records from our institution in our VIVO instance. The next step is to adjust IREMA and select what visualisations would be helpful for the analysis of education and which will be applied to explore the intersections of education and research in HEIs. Finally, we want to populate a data analysis endpoint (API) from which it will be possible to perform analysis in any VIVO instance.

VI. References

[1] Tsolakidis, A., Sgouropoulou, C., Papageorgiou, E., Terraz, O., & Miaoulis, G. (2013). Using Visual Representation for Decision Support in Institutional Research Evaluation. In Intelligent Computer Graphics 2012 (pp. 41-57). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-31745-3.

[2] Triperina, E., Sgouropoulou, C., Xydas, I., Terraz, O., & Miaoulis, G. (2015). Creating the context for exploiting linked open data in multidimensional academic ranking. International Journal of Recent Contributions from Engineering, Science & IT (iJES), 3(3), 33-43. http://dx.doi.org/10.3991/ijes.v3i3.5023.

[3] Anastasios, T., Sgouropoulou, C., Xydas, I., Terraz, O., & Miaoulis, G. (2011, September). Academic research policy-

making and evaluation using graph visualisation. In Informatics (PCI), 2011 15th Panhellenic Conference on (pp. 28-32). IEEE. https://doi.org/10.1109/PCI.2011.38.

[4] Zimmerman, E. (2002, August). CRIS-Cross: current research information systems at a crossroads. In Proceedings of the 6th International Conference on Current Research Information Systems, University of Kassel (pp. 11-20).

[5] Koopmans, N. I. (2002). What's your question? The need for research information from the perspective of different user groups.

[6] Conlon, M., & Corson-Rikert, J. (2012). VIVO: A Semantic Approach to Scholarly Networking and Discovery (Vol. 2). Morgan & Claypool Publishers. https://doi.org/10.2200/S00428ED1V01Y201207WEB002.

[7] EuroCRIS, Current Research Information Systems, www.eurocris.org

[8] Ebeling, B., Klages, M., & Breitner, M. H. (2011). IT-gestütztes Management von Drittmitteln im Rahmen des Forschungsmanagements an deutschen Hochschulen. Informatik.

[9] Azeroual, O., & Abuosba, M. (2019). Improving the data quality in the research information systems. arXiv preprint arXiv:1901.07388.

[10] Bevan, S., & Harrington, J. (2011). Managing research publications: lessons learned from the implementation of a Current Research Information System. Serials, 24(1). https://doi.org/10.1629/2426.

[11] Zelepukhina, V. A., Danilova, T. S., Burmistrov, A. S., & Tarasevich, Y. Y. (2014). Particular experience in design and implementation of a Current Research Information System in Russia: national specificity. Procedia Computer Science, 33, 168-173. https://doi.org/10.1016/j.procs.2014.06.028.

[12] Johansson, Å., & Ottosson, M. O. (2012). A national current research information system for Sweden.

[13] Biesenbender, S., Petersohn, S., & Thiedig, C. (2019). Using Current Research Information Systems (CRIS) to showcase national and institutional research (potential): research information systems in the context of Open Science. Procedia Computer Science, 146, 142-155. https://doi.org/10.1016/j.procs.2019.01.089.

[14] Scholze, F., & Maier, J. (2012). Establishing a research information system as part of an integrated approach to information management: Best practice at the Karlsruhe Institute of Technology (KIT). Liber Quarterly, 21(2), 201-212. https://doi.org/10.18352/lq.8019.

[15] Dimou, A., De Vocht, L., Van Grootel, G., Van Campe, L., Latour, J., Mannens, E., & Van de Walle, R. (2014). Visualising the information of a linked open data enabled research information system. Procedia Computer Science, 33, 245-252. https://doi.org/10.1016/j.procs.2014.06.039.

[16] Parinov, S., Lyapunov, V., Puzyrev, R., & Kogalovsky, M. (2015). Semantically enrichable research information system SocioNet. In Knowledge Engineering and Semantic Web: 6th International Conference, KESW 2015, Moscow, Russia, September 30-October 2, 2015, Proceedings 6 (pp. 147-157). Springer International Publishing. https://doi.org/10.1007/978-3-319-24543-0_11.

[17] Cao, H., He, H., & Tian, J. (2022). A Scientific Research Information System via Intelligent Blockchain Technology for the Applications in University Management. Mobile Information Systems, 2022. https://doi.org/10.1155/2022/7512692.

[18] Benmoussa, K., Laaziri, M., Khoulji, S., & Kerkeb, M. L. (2018). Intelligent system for the use of the scientific research information system. International Journal of Advanced Computer Science and Applications, 9(6). https://doi.org/10.14569/IJACSA.2018.090619.

[19] Benmoussa, K., Laaziri, M., Khoulji, S., Larbi, K. M., & El Yamami, A. (2019). Enhanced model for ergonomic evaluation of information systems: application to scientific research information system. International Journal of Electrical and Computer Engineering, 9(1), 683. https://doi.org/10.11591/ijece.v9i1.pp683-694.

[20] Asserson, A., Jeffery, K. G., & Lopatenko, A. (2002). CERIF: past, present and future: an overview.

[21] Pinto, C. S., Simões, C., & Amaral, L. (2014). CERIF–Is the standard helping to improve CRIS?. Procedia Computer Science, 33, 80-85. https://doi.org/10.1016/j.procs.2014.06.013.

[22] Parinov, S. (2014). Towards an open data on how the research data are used: CRIS-CERIF based approach. Procedia Computer Science, 33, 55-59. https://doi.org/10.1016/j.procs.2014.06.009.

[23] Corson-Rikert, J., Mitchell, S., Lowe, B., Rejack, N., Ding, Y., & Guo, C. (2012). The VIVO ontology. In VIVO: A Semantic Approach to Scholarly Networking and Discovery (pp. 15-33). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-79435-3_2.

[24] Krafft, D. B., Cappadona, N. A., Caruso, B., Corson-Rikert, J., Devare, M., & Lowe, B. J. (2010, April). Vivo: Enabling national networking of scientists. InProceedings of the Web Science Conference (Vol. 2010, pp. 1310-1313).

[25] Albert, P., Holmes, K. L., Borner, K., & Conlon, M. (2012, June). Research discovery through linked open data. In Proceedings of the 12th ACM/IEEE-CS joint conference on Digital Libraries (pp. 429-430). ACM. https://doi.org/10.1145/2232817.2232926.

VII. AUTHORS

Dr. Anastasios Tsolakidis received his PhD degree in computer science from the University of Limoges, France, in 2015. His research interests lie in the fields of Visual Analytics, Decision Support Systems, Business Intelligence and E-health. During his PhD studies, he has been collaborating with the Quality Assurance Unit of the Technological Educational Institute of Athens, as Data Scientist and since July 2017 he has been working as Business Intelligent Analyst at "e-Government Center for Social Security (IDIKA SA)" at the sector of E-Health

Evangelia Triperina holds a PhD in Computer Science from the University of Limoges (France), with a thesis entitled "Visual interactive knowledge management for multicriteria decision making and ranking in linked open data environments". She is a Department of Computer Engineering graduate of TEI of Athens. She holds an MSc in Information Technology, Image Synthesis and Computer Graphics from the University of Limoges (France). She worked in European research projects at GRNET, Agro-Know Technologies and the University of West Attica.

Ioannis D. Triantafyllou holds a PhD from the National Technical University of Athens, Department of Electrical & Computer Engineering, and is currently an Associate Professor at the Department of Archives, Library and Information Studies at the University of West Attica. He has previously worked as a research associate in many European and Greek

research/projects at the Institute of Language & Speech Processing (ILSP /Athena RC). Recently, he participated in the CrossCult research program (Horizon2020) as a research team member. He specialises in Digital Libraries, Data & Text Mining, Text Classification & Clustering, Ontologies & Metadata, Linked Data, Information Extraction, Text & Information Retrieval, Automated Summary & Text Synthesis, Translation Memories, etc.

Christos Skourlas is an emeritus professor at the Department of Informatics and Computer Science of the University of West Attica. He was an analyst-programmer and head of the systems with the National Documentation Centre of Greece (1983- 89) and a research assistant with the Nuclear Research Centre "Demokritos" (1977-82). He was head of the research lab "Data, Information and Knowledge Management (InfoDat_KM)". He participates as a coordinator and/or key researcher in European and nationally funded research and development projects. His research work has been published in international journals and conference proceedings.

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