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Editorial message

Dear Colleagues,

JIIM is an international, multidisciplinary, blind, peer-reviewed, open-access electronic journal that publishes research on all aspects of Information Science and Integrated Information Management. JIIM is the official journal of the Department of Archival, Library & Information Studies, University of West Attica (UNIWA), and it is available through the Greek National Documentation Centre (EKT) ePublishing platform for electronic journals: https://ejournals.epublishing.ekt.gr/index.php/jiim.

The current issue publishes research articles on the artificial ageing of paper, decorated papers in bookbinding, the alignment of scholarly journal submission evaluation criteria in Library and Information Science, Communication, History and Philosophy, and problem-based e-learning.

Initially, the scientific foundations, methodologies, and technologies employed in the artificial aging of paper reflect the effects of various environmental conditions on books, journal volumes, and other physical paper materials in libraries. Experimental evaluation of artificial aging can inform the development of mathematical models of paper degradation, which is valuable for storage decisions in libraries.

The following paper also addresses the physical condition of books and focuses on 19th-century bookbinding. It proposes a systematic metadata schema to support library management. The decorated papers used in books as covers, cover parts, or endpapers reflect physical characteristics associated with the historical bookbinding techniques applied or with the paper's origin.

The third paper outlines the evaluation criteria for scholarly journal submissions in Library and Information Science, Communication, History, and Philosophy. Eleven criteria were found: adequacy of data to support the conclusions, consistency of conclusions with research goals and data, clarity and readability of the evaluated article, balance and accuracy of bibliographic references, compliance with ethical standards of research, reliability and reproducibility of methodology, significance of the quality and clarity of tables, graphs and figures, relevance and originality of the research question or topic, optimization of the title, abstract keywords for search engines, effectiveness of the introduction in establishing research framework, originality, and aims, and coherence and logic of the article's argument.

Finally, the problem-based e-learning (PBL) application at the Department of Business Administration at the University of West Attica during and after the Covid-19 pandemic, when distance education was widely implemented, used Microsoft Teams analytics and the Motivated Strategies for Learning Questionnaire (MSLQ). The findings indicated that the proposed instructional design approach, based on the PBL method, had a positive effect on students' intrinsic motivation and self-efficacy, but no effect on their extrinsic motivation.

We welcome proposals for Special Issues, which should be emailed to Associate Professor Dimitrios Kouis (dkouis@uniwa.gr) or Assistant Professor Artemis Chaleplioglou (artemischal@uniwa.gr). We expect your contributions, active support, comments, and suggestions for improvement. The JIIM Editorial Team wishes all of you Happy Holidays and a Happy New Year.

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Artificial Ageing of Paper: Scientific Foundations, Methodological Framework, and Applications in Archival and Library Preservation

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Abstract:

Purpose *- This paper presents the theoretical basis, methodological framework, and practical applications of the artificial ageing of paper, a key technique for predicting and improving the long-term stability of archival and library materials. It aims to familiarize conservators, archivists, and librarians with the fundamental concepts necessary for interpreting scientific literature and making informed preservation decisions.*

Design/methodology/approach *- The article introduces key chemical mechanisms of paper ageing, particularly acid hydrolysis and oxidation of cellulose. It presents standardized accelerated ageing methods and discusses two core indicators of paper degradation: degree of polymerization and folding endurance. Mathematical models are employed to explain ageing rates and reaction kinetics, including Arrhenius-based estimations of useful paper lifespan. Experimental setups for artificial ageing and comparative evaluations of conservation treatments are illustrated using both real and hypothetical data.*

Findings *- This article synthesizes well-established scientific knowledge and practical methods related to artificial ageing of paper. By organizing complex concepts into an accessible framework, it clarifies how artificial ageing can be used to assess paper stability, evaluate conservation interventions, and understand the influence of environmental conditions. The discussion reinforces widely accepted conclusions in the field, such as the impact of acidity, the role of deacidification, and the value of alkaline-buffered materials.*

Originality/value *- This paper is intended as both a practical reference and an educational tool. It bridges scientific methodology and conservation practice, offering a synthesis of theory, standards, and field applications. It enhances the scientific literacy of preservation professionals and supports evidence-based conservation and storage decisions. The clear mathematical modeling of degradation processes makes the content accessible even to readers without advanced technical backgrounds.*

Practical implications *- The synthesis presented here can guide practitioners in selecting conservation treatments, evaluating storage materials, and establishing preservation conditions to help extend the lifespan of archival holdings.*

Research limitations/implications *- While accelerated ageing simulates natural degradation, extrapolations to long-term behavior must be made cautiously due to potential non-linearities and model assumptions.*

Index Terms **—** Artificial ageing; Ageing kinetics; Paper degradation; Arrhenius equation; Archival storage; Deacidification.

I. Introduction

This article presents the theoretical background, mathematical framework, and practical applications of artificial paper ageing in the conservation and preservation of archival materials and books.

Key applications of accelerated ageing as a methodological tool include [1-3]:

- Investigating factors influencing paper ageing rates, with a focus on temperature, relative humidity, and pH.
- Investigating the mechanisms and the kinetics of paper deterioration.
- Evaluating conservation methods and materials used in paper preservation.
- Determining optimal storage conditions for archival and library materials.
- Estimating the useful lifespan of various types of paper.
- Developing paper with enhanced chemical and mechanical stability, suitable for long-term preservation (permanent paper).
- Researching and selecting appropriate materials and methods for archival storage, including archival papers, cardboard, and adhesives.

Understanding the principles and rationale behind the development of archival and library storage and preservation standards enables professional archivists and librarians to fully appreciate their importance, as well as the consequences of non-compliance. This knowledge also equips them to make informed and conscious decisions when standard guidelines and "preservation formulas" are insufficient or unavailable.

The additional applications of artificial ageing presented

in this article introduce key concepts essential for interpreting preservation and conservation literature. These concepts are directly linked to preservation and conservation management within archives and libraries. A strong grasp of these principles will help archivists and librarians effectively utilize scientific literature to protect and safeguard the written cultural heritage.

To support readers lacking formal education in chemistry or mathematics, this article offers foundational explanations, supplemented by simplified examples and the underlying mathematical principles employed in the presented calculations.

II. Basic Concepts

A. Composition of Paper

Paper is primarily composed of plant fibers that have undergone various treatments. In hand papermaking, it is formed by filtering a suspension of fibers (paper pulp) through a specially designed sieve-like screen known as mould. The fibers deposit onto the screen, forming a relatively uniform layer that, when dried, acquires cohesion and mechanical strength. [4]-[5].

The fibers are essentially plant cells with various components removed. Cellulose (Fig. 1), a natural polymer, is the main component of plant cells and is the desired raw material for making paper. Thus, the various treatments of the original vegetable matter aim to purify the cellulose to varying degrees, depending on the desired quality and yield of the final product. The best quality paper is produced from cotton, linen or chemical pulp (wood pulp with the lignin chemically removed, [4]-[5]). Newsprint is produced from wood pulp that contains a large part of the original components of plant matter (mechanical pulp, mainly produced by mechanical pulping of wood, [4]-[5]).

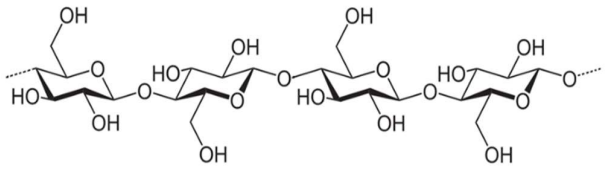

Fig. 1*. The cellulose macromolecule is composed of n β-glucose ($C_6H_{12}O_6$) units linked by 1→4 β-glycosidic bonds, with the simultaneous release of n-1 water molecules. n equals the degree of polymerization explained below.*

Cellulose is a linear polymer of β-glucose ($C_6H_{12}O_6$, Fig. 2) [4]-[6]. It consists of a large number of glucose molecules (in typical paper varying from 800 to 2,000) linked by β-(1→4) glycosidic bonds (Fig. 3). As the primary component of paper, cellulose plays a crucial role in determining its mechanical strength.

In addition to cellulose, other components of paper derived from the original plant material are hemicelluloses and lignin [4]. Hemicelluloses are polymers of various sugars, similar in chemical composition to cellulose. They are compounds of relatively low molecular weight and a significant part of them remains in the paper. Lignin is also a polymer found in high concentrations in wood, but with a completely different chemical composition and structure from cellulose. Lignin is a structural component of plants, deposited around cellulose fibers, where it acts like cement, while the cellulose fibers serve as reinforcement, similar to an iron framework in the plant's structure. Lignin is partially or completely removed from the chemical pulps, while a large part of it remains in the mechanical pulps. Due to its rigidity and hydrophobic nature, it does not allow for strong interconnections between the paper fibers. Thus, paper containing lignin has low initial mechanical strengths and, due to the chemical instability of lignin, changes color during ageing (yellowing, [7]). However, lignin does not appear to affect the mechanical permanence of papers made from mechanical pulp, as it functions as an antioxidant. [8-10].

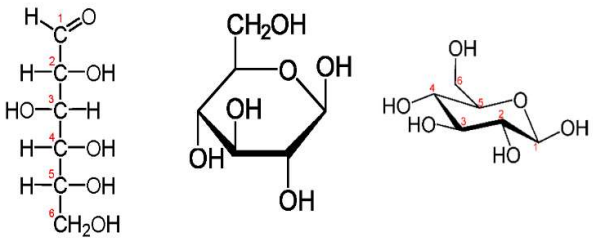

Fig. 2. *Structural and stereochemical formulas of β-glucose. The designation β- indicates that the –OH group on carbon 1 is oriented upwards. Cellulose is composed of β-glucose monomers linked between carbons 1 and 4 via an oxygen bridge. In the second and third formula, the carbon and single hydrogen atoms are omitted.*

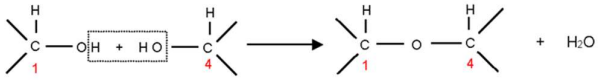

Fig. 3*. Formation of a glycosidic bond. The glycosidic bond is formed and a water molecule is removed from the hydroxyls (-OH) of carbons 1 and 4 of two adjacent glucose molecules. The two carbons are connected by an oxygen bridge.*

Paper is a hygroscopic material, meaning it absorbs or releases moisture from the surrounding air until it reaches Equilibrium Moisture Content (EMC). The relative humidity (RH) of the environment is the primary factor that determines the water content of paper, while temperature influences the rate at which moisture is absorbed or desorbed. At ambient temperatures and 50% RH, the moisture content of most common types of paper typically ranges between 5% and 7%.

B. Mechanisms of the Natural Ageing of Paper

During paper ageing, the main chemical degradation mechanism is the partial hydrolysis of the glycosidic bonds due to the presence of acids (acid hydrolysis of cellulose). Hydrolysis, as its name suggests, is the breaking of a chemical bond with the simultaneous addition of water [2]-[4]-[6]. The necessity of the presence of water explains why increasing humidity increases the rate of hydrolysis [11]. This reaction can be represented schematically with the opposite course of the reaction shown in Fig. 3. The result of partial hydrolysis is the breaking of cellulose macromolecules into

smaller pieces, which are also shorter cellulose macromolecules that contain fewer glucose molecules than the original. This reduction in the average length of cellulose macromolecules has severe consequences for paper, leading to diminished mechanical strength and flexibility, increased brittleness, and, in extreme cases, the potential disintegration of the paper sheet during use.

Hydrolysis of cellulose is catalyzed [1] by acids (acid hydrolysis) and enzymes [2]-[4]-[6]. Acids are absorbed from the environment, particularly from acidic air pollutants, introduced during paper manufacture, or produced during paper ageing [2]-[12]-[13]. Enzymes are secreted by microorganisms such as fungi and bacteria [14].

Other chemical mechanisms, such as oxidation, act synergistically to accelerate cellulose hydrolysis and, consequently, the ageing of paper. Oxidation plays a significant role in the color change (yellowing) of paper over time [7]-[15].

C. Artificial or Accelerated Ageing

The method of accelerating the ageing of a material by increasing the temperature to draw conclusions about its natural ageing at ambient temperatures is known as thermal artificial ageing or accelerated ageing. For the straightforward comparison of the ageing resistance (permanence) of various types of paper over time, the International Organization for Standardization (ISO) has standardized four thermal artificial ageing procedures, the most commonly used of which is described in ISO 5630-3 [16]. This standard prescribes exposing samples to a temperature of 80°C and 65% relative humidity for one or more time intervals. Selected paper properties (typically folding endurance or degree of polymerization) are measured before and after artificial ageing, and the retention of these properties is calculated. The greater the retained value of these properties after artificial ageing, the higher the paper's resistance to ageing.

This simple and rapid method can also reveal the impact of various treatments (such as different conservation interventions) on the ageing resistance of a paper type [1]-[17]. This method is accepted even by critics of using the Arrhenius equation (see below) to estimate the useful lifespan of paper [2]-[18]-[19]. Readers interested in the natural and artificial ageing of paper and cellulose are referred to the literature reviews on these topics by Fellers et al. [20], Emsley and Stevens [21] and Zervos [2].

D. Two Important Properties of Paper

At this point, the definitions of two key properties of paper are provided, as they are important indicators of paper degradation and will be essential for the subsequent discussion.

Degree of Polymerization (DP) of cellulose. The number of glucose molecules linked together to form a cellulose macromolecule is referred to as the Degree of Polymerization. [4]-[6]. Cellulose macromolecules derived from natural sources exhibit varying degrees of polymerization, even in the same paper sample. Thus, an average value, the average degree of polymerization, is used to characterize a specific paper sample. The degree of polymerization for cotton is approximately 7,700 (and can reach up to 12,000), around 3,000 for wood cellulose, and between 600 and 1,600 for processed wood pulp.

The degree of polymerization of cellulose can be measured by several methods. One commonly used approach is viscometry, where the intrinsic viscosity of a cellulose solution is measured, and DP is calculated based on established relationships between viscosity and chain length [6]-[22]. Another method involves gel permeation chromatography (GPC) [2], which separates cellulose molecules by size, allowing for a more direct assessment of molecular weight distribution and DP [23]-[24].

The average degree of polymerization of the cellulose contained in a paper sample is related to its mechanical strength and its general quality. During both natural and accelerated ageing of paper, the average degree of polymerization decreases due to the hydrolysis mechanism, as explained earlier. If the initial degree of polymerization is DP_0 and after ageing for time t it decreases to DP_t, the fraction of the broken glycosidic bonds (δ) at the end of time t can be calculated using equation (1) [2]-[11]-[20]:

$$\delta = \frac{1}{\mathrm{DP_t}} - \frac{1}{\mathrm{DP_0}} \quad (1)$$

Studies have shown that during the initial stages of hydrolysis, the fraction of broken glycosidic bonds (δ) increases linearly with ageing time (2), indicating a constant rate of bond breakage [2]-[11]-[25]:

$$\delta = k \cdot t \quad (2)$$

where k is the rate constant and t the ageing time.

Monitoring the number of bonds broken during ageing provides authentic chemical kinetics data, as it is directly linked to the chemical mechanism of ageing, the cleavage of glycosidic bonds.

Folding Endurance. The decimal logarithm of the number of complete folds a paper specimen can withstand under tension before breaking (3) [20]-[26]]:

$$Folding\ Endurance = FE = log\,[number\ of\ folds] \quad (3)$$

The measurement is carried out on a strip of paper 15 mm wide and 10 cm long as shown in Fig. 4 [26]. Folding endurance is the most sensitive mechanical property for the detection of changes induced to the samples by accelerated or natural ageing, since it decreases faster than other mechanical properties of paper [1]-[2]-[17]-[27] and is directly connected to paper usability [17]-[28]. Its dependence on the ageing time at the initial stages of ageing is also linear, that is, its graph as a function of time is a straight line [2]-[29]-[30]. For these reasons it is the most commonly used mechanical property for determining the

[1]Catalysis: acceleration of a reaction due to the presence of a substance, the catalyst, which is not consumed during the reaction.

[2] Synonym: size exclusion chromatography (SEC)

rate of paper ageing.

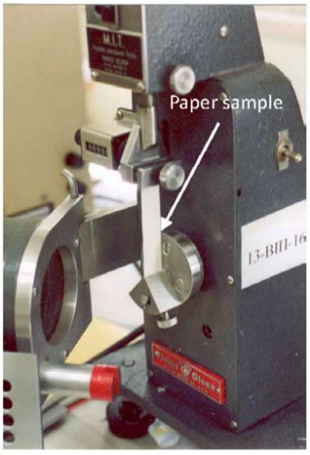

Fig. 4. *The folding endurance tester of the General Chemical State Laboratory (G.C.S.L.) in Athens [MIT instrument type, [20 p. 27]]. The paper sample is held by two clamps. The lower clamp is movable and folds the sample to an angle of 135° in either direction. The desired stress is applied to the specimen by an adjustable spring.*

III. Determination of the Rate of Paper Ageing

Ageing leads to the deterioration of the physical, chemical, and mechanical properties of paper. The rate of ageing is determined through experiments that monitor and record the degradation rate of these properties. Among the most commonly used indicators are the Degree of Polymerization (DP) and Folding Endurance (FE).

In the next discussion, the determination of the rate of paper ageing will be demonstrated by monitoring folding endurance[3], followed by assessing the fraction of broken bonds, in two fictional experiments based on accelerated ageing of two different specific types of paper.

These fictional experiments, though based on hypothetical values for folding endurance and degree of polymerization, demonstrate a plausible approach to determining the rate of ageing for two specific types of paper at a specific temperature and relative humidity (here, 80°C and 65% RH). Both experiments take place in a ventilated[4] laboratory oven capable of maintaining stable and uniform temperature and humidity conditions. An adequate quantity of paper samples is suspended within the oven, and at predetermined intervals a set of samples is removed from the oven and tested for the desired property.

In the first experiment, the rate of ageing is determined by following folding endurance. Each set of samples is removed from the oven, preconditioned at 23°C and 25% relative humidity for 24 hours, and then conditioned at 23°C and 50% relative humidity for an additional 24 hours[5]. Once conditioning is complete and under the same environmental conditions, the folding endurance of each set of samples is measured.

To clarify the process, imagine that the experiment begins with 60 strips of paper. Initially, 10 strips are set aside, preconditioned, conditioned, and then tested for folding endurance, with the result recorded as the average of these 10 measurements. After 10 days of ageing, another 10 strips are removed from the oven, preconditioned, conditioned, and measured for folding endurance. This process is repeated every 10 days until the experiment concludes on the 50th day. The results are presented in the following Table I[6]:

Table I*: Folding Endurance values against days of ageing*

Days of Ageing (d)	0	10	20	30	40	50
Folding Endurance (FE)	2.81	2.75	2.69	2.66	2.61	2.54

The folding endurance values are then plotted against ageing time (Fig. 5).

The points on the graph do not align perfectly in a straight line, but they are close enough to suggest a linear relationship[7]. Using a mathematical technique called linear regression, a straight line that best fits these points can be drawn, and its equation can be calculated[8] (4):

$$FE = -0.0051 \cdot d + 2.8052 \quad (4)$$, *d* stands for days

According to equation (4), the rate of change in folding endurance (FE) equals -0.0051 per day of ageing, which can be considered the ageing rate for the specific paper tested under the conditions of the experiment. The negative sign indicates a decline in FE over the course of the experiment. This analysis is only valid if the data points align closely with a straight line, or else, fit the linear model well enough, to justify this approach.

[3] Experiments that monitor paper properties other than the fraction of broken glycosidic bonds δ, such as mechanical or optical properties, fall under the category of "Property Kinetics" studies.

[4] Specialized ovens that continuously renew the internal atmosphere are employed, a necessary condition for the effective removal of gaseous by-products generated during the ageing process. This is significant, as the accumulation of such products may influence the kinetics of the ageing reactions.

[5] Folding endurance is highly dependent on the paper's water content. Preconditioning and conditioning are essential to obtaining accurate results, as they standardize the humidity absorbed by the samples, ensuring a consistent moisture level across all measurements.

[6] Recall that FE = log [number of folds]. If for example the sample withstands 1000 folds, then FE = log 1000 = 3. The first value of FE in Table I is 2.81 and it corresponds to 646 folds (log646 = 2.81).

[7] In real life experiments, the points may not fit the linear model so well. However, it is important to remember that this experiment is fictional, and the values are hypothetical, intended solely to illustrate the procedure.

[8] This can easily be performed using spreadsheet software like Microsoft Excel or statistical software such as SPSS. The linear model follows the general equation $y = ax + b$, where a represents the slope of the line, indicating the rate of change in y (in this case, folding endurance, FE). The coefficient of determination, R^2, can also be calculated effortlessly using these tools. R^2 reflects how well the data align with the regression model, demonstrating the goodness of fit. R^2 equals 1 for a perfect fit. In this experiment, R^2=0.9904, indicating an excellent fit to the linear model.

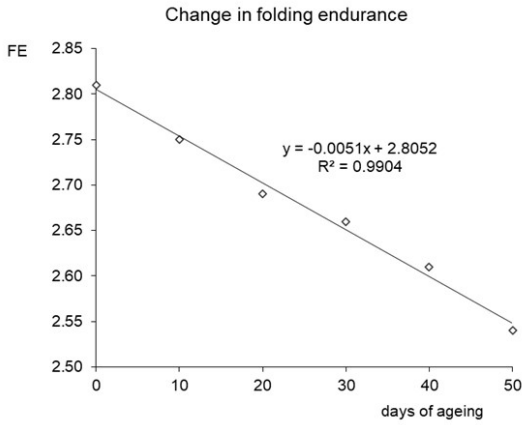

Fig. 5. *Plot of the FE values against days of ageing*

Here, it is assumed that the rate of the reaction k equals the rate of the reduction in the FE values, which can be calculated by the following formula (5):

$$Ageing\ rate = k = \frac{cha \quad in\ FE}{time} \quad (5)$$

A similar process applies if, instead of monitoring folding endurance, the change in the fraction of glycosidic bonds broken during ageing (δ) is observed. In this second experiment, the withdrawal of a set of two paper samples occurs every 5 days. The degree of polymerization is determined as the average DP value of the two paper samples and from this, the fraction of broken bonds (δ) is calculated using equation (1). This fictional experiment might yield the results shown in Table II.

Table II*: δ values against days of ageing*

Days of Ageing (d)	0	5	10	15	20	25
Fraction of broken bonds (δ)	0	0.00023	0.00037	0.00062	0.00077	0.00096

The values of the fraction of broken bonds are then plotted against ageing time (Fig. 6). As in the case of folding endurance, the points in the graph are not exactly in a straight line, but again they are very close to it, suggesting that this process is also linear. Once again, a straight line that best fits the points is drawn using linear regression, and its equation is calculated (6):

$$\delta = 0.00004 \cdot d \quad (6),\ d \text{ stands for days}$$

The only difference in this case is in the shape of the graph. This would be a straight line passing through zero, and the calculated rate would be positive, as more bonds break with ongoing ageing. According to equation (6), the rate of change in δ for this paper is 0.00004 bonds per day of ageing[9].

As seen above, it is assumed again that the rate of the reaction k at 80°C and 65% relative humidity equals the rate of the reduction in the δ values, which is calculated by a similar formula (7):

$$Ageing\ rate = k = \frac{change\ in\ \delta}{time} \quad (7)$$

Examples of the methodology demonstrated above are widely available in the relevant literature. For instance, see Roberson [30 p. 148, fig. 1] and Feller et al. [25 p. 18, fig. 4]. Additionally, there is an extensive body of literature for those interested in exploring the natural and accelerated ageing of paper in greater detail [2]-[16]-[20]-[31-40].

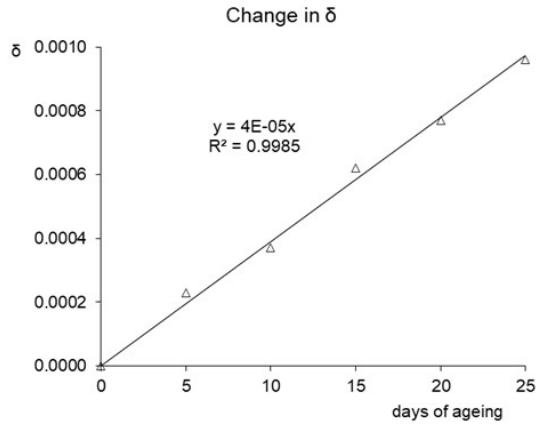

Fig. 6. *Plot of δ values against days of ageing*

IV. Arrhenius Studies – Determination of the Useful Lifespan of Paper

In the previous chapter, the determination of the ageing rate of paper at a relatively high temperature was demonstrated. The same methods could theoretically be applied to estimate the useful life of paper stored in libraries and archives at ambient temperatures. However, this approach poses a significant practical challenge: paper ageing at room temperature is an exceptionally slow process. Detectable changes in the properties of paper may require many years to manifest. Although such long-term experiments have been conducted [18]-[41] and others are in progress [42], a method that could provide relatively rapid and scientifically valid results is highly desirable. Such a method exists [2]-[11]-[29]-[43]-[44] and is grounded in a fundamental principle of chemistry expressed mathematically by the Arrhenius equation (8):

$$k = A \cdot e^{-\frac{E_a}{R \cdot T}} \quad (8)$$

where k is the rate constant, A is the pre-exponential factor (or Arrhenius factor or collision frequency factor), E_a is the activation energy of the reaction, R is the universal gas constant and T is absolute temperature (°K)[10].

The Arrhenius equation quantifies the well-known chemical principle that reaction rates increase with rising temperature. Its importance lies in its ability to link the rate constant k of a reaction to temperature. Given the values of A and E_a, this equation enables the calculation of the reaction's rate constant at any specified temperature. Before examining how this is done, it is necessary, for

[9] R^2=0.9985.

[10] The constant R has a value of 8.314 J/K·mol. To convert temperature θ from degrees Celsius to Kelvin (T), the following relationship is used: T (in Kelvin) = θ (in Celsius) + 273.

reasons of scientific validity, to discuss the extent to which the above equation can be used to the study of paper ageing [11].

The Arrhenius equation applies to a specific chemical reaction, where the rate constant k represents the rate at which particular quantities of reactants are converted into products. However, the ageing of paper involves a multitude of reactions, some occurring in parallel, others in sequence, and some in competition. It has been shown that in such cases, the equation can be used under a certain condition [11], which will be discussed later.

Regarding the reaction rate, if the monitoring of δ (fraction of broken bonds) is used, there is no concern, as this approach provides authentic chemical kinetics data, as previously mentioned [45]. However, if folding endurance or another property of paper is used, the measurements do not pertain to quantities of reactants and products but rather to the change in a mechanical property of the paper [45].

On the rationale that changes in paper properties are due to the chemical alterations it undergoes during ageing, many researchers have applied the methodology based on the Arrhenius equation to the study of paper ageing by following the change in FE [30]-[43-48]. While a degree of skepticism exists within part of the scientific community regarding this logical leap [27]-[48]-[49], the methodology to be presented is widely accepted, and its results to date have shown few inconsistencies or gaps. In the following analysis, the terms "rate constant, k" and "reaction rate" are used interchangeably, even though they do not strictly align with their precise scientific meanings.

As discussed above, the problem of calculating the reaction rate at any given temperature T is reduced to determining the values of A and E_a. This calculation is accomplished through the following technique. First, equation (8) is transformed into its equivalent, equation (9), which is more convenient to use. This transformation is achieved by taking the natural logarithm[11] of both sides of the equation[12]:

$$k = A \cdot e^{-\frac{E_a}{R \cdot T}} \Rightarrow ln\, k = ln(A \cdot e^{-\frac{E_a}{RT}}) \Rightarrow$$

$$ln\, k = ln\, A + ln\, e^{-\frac{E_a}{RT}} \Rightarrow ln\, k = ln\, A - \frac{E_a}{RT} \Rightarrow$$

$$ln\, k = -\frac{E_a}{R} \cdot \frac{1}{T} + ln\, A \quad (9)$$

Equation (9) has the following general form:

$$y = \alpha \cdot x + \beta \quad (10)$$

where y = lnk , α = - $\frac{E_a}{R}$, x = $\frac{1}{T}$, and β = lnA.

The general equation y = α·x + β (10) for negative α produces a straight-line graph as depicted in Fig. 7. The line intersects the y-axis at β (correspondingly, for equation (9) at the point lnA) and has a slope tanω = α [for equation (9), the slope tanω = - $\frac{E_a}{R}$ (Fig. 7).

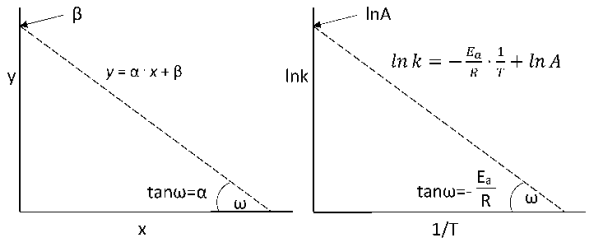

Fig. 7. *Generalized plots of equation y = α·x + β and Arrhenius equation.*

By plotting lnk as a function of 1/T, the value of lnA can be determined from the intercept of the graph with the y-axis, and $\frac{E_a}{R}$ (and thus E_a, since R is known) from the slope of the line. Alternatively, computational methods (linear regression analysis) can also be used, as shown below. Such a plot is called an Arrhenius plot. This can be achieved by calculating the ageing rate (i.e., the rate constant k) as shown above at various temperatures and constructing the plot of lnk as a function of 1/T.

The results of such an experiment are presented below [Table III, equation (11) and Fig. 8]. This experiment consists of a series of tests similar to the one described in Section 3, where the rate of change in the fraction of the broken bonds (k) is measured at various temperatures using accelerated ageing. Typically, temperatures below 100°C are used to avoid triggering reactions in the paper that wouldn't occur at room temperature, and above 50°C to minimize the sample dwell time in the oven. It goes without saying that longer times are used for lower temperatures. It is crucial in these tests to maintain a constant paper water content, uniform across all temperatures, which is achieved by appropriately adjusting the relative humidity according to the oven temperature.

Table III: Rates (k) of change in the fraction of broken bonds (δ) and lnk at five different temperatures, as measured by accelerated ageing experiments according to the method shown in Chapter 3.

θ (° c)	1/T (° K)	k (days^{-1})	lnk
90	0.00275	0.00023143	-8.3721
80	0.00283	0.00008919	-9.3257
70	0.00292	0.00002197	-10.7271
60	0.00300	0.00000885	-11.6368
50	0.00310	0.00000200	-13.1237

Once the rates k at the chosen temperatures are determined, their logarithms (lnk) and the inverses of the absolute temperatures (1/T) are calculated, and a plot of lnk as a function of 1/T is constructed. From this plot, the values of lnA and E_a can be determined either graphically or through computational methods (linear regression analysis). For this calculation to be valid, the plot must form a straight line, which is the condition previously mentioned as

[11] The natural logarithm of a number is its logarithm to the base of the mathematical constant e, which is approximately equal to 2.718. The natural logarithm of x is the power to which e should be raised to equal x.

[12] The following properties of logarithms are applied for the conversion: ln(a · b) = lna + lnb and ln(e^x) = x

necessary for this methodology to be applicable [11].

The points in the graph (Fig. 8), although not exactly in a straight line, they are very close to it, indicating that the process is linear and that the above-mentioned methodology is applicable. A straight line that best fits the points is drawn using linear regression with the following equation (11):

$$\ln k = -13863 \cdot \frac{1}{T} + 29.847 \quad (11)$$

From equation (11), the value of $\frac{E_a}{R}$ is derived, which equals 13863, and the value of lnA, which is 29.847. By solving for Ea and substituting R by its value (8.124 j/mol), E_a is calculated as 115,257 J/mol or 115.257 kJ/mol. A is derived from lnA as 9.14×10^{12}. Both values of E_a and A closely align with values reported in the literature [2]-[11][13].

Equation (11) can now be used to calculate the value of lnk and, from that, the value of k at any given temperature. Assuming that room temperature is 20°C, from equation (11) the rate constant k is calculated to be 2.85×10^{-8}. Comparing this to the rate constant at 80°C (which is 8.92×10^{-5} according to Table III), ageing at that temperature is 3,128 times faster, meaning that for this specific type of paper, 1 day of ageing at 80°C corresponds to approximately 10 years of natural ageing at 20°C. Knowing the time required for the fraction of broken bonds or folding endurance at 80°C to fall below a critical threshold, rendering the paper unusable, the time needed for the same effect to occur at 20°C can be calculated. In this way, the useful lifespan of a specific type of paper can be estimated. However, such conclusions should be regarded with caution, as experimental errors are significant. For a more comprehensive discussion on the limitations of the Arrhenius methodology presented here, interested readers are encouraged to consult the relevant literature [2]-[48]. Wilson and Parks [19] proposed using this methodology to classify different types of paper into permanence categories: less than 50 years, between 50 and 100 years, and several hundred years. Zou et al. [11] present plots of δ versus accelerated ageing time, illustrating the effects of temperature [11 p. 250, fig. 2] and relative humidity [11 p. 252, fig. 4] on the ageing rate. They also provide an Arrhenius plot on a logarithmic y-axis based on these results [11 p. 251, fig. 3].

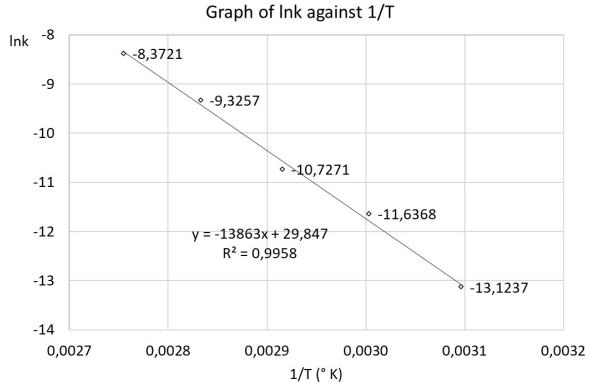

Fig. 8. *Plot of the lnk against inverse absolute temperature (1/T)*

V. Applications

A. Effect of Acidity on the Ageing Rate of Paper - Deacidification

It was observed early on that while a significant portion of historical handmade papers, produced between the 15th and the middle of 19th century, retained good mechanical strength and acceptable color, most modern papers, manufactured from around the mid-19th to the late 20th century, deteriorated rapidly. As a result, many became unusable within just a few decades of their production.

The studies conducted by Barrow and Sproull [28] established the now widely accepted view that the primary cause of the degradation of modern papers was their increased acidity. This conclusion was supported by measuring the rate of loss in folding endurance among papers with varying acidity levels, using the methodology described earlier [28 p. 1083, fig. 7].

Taking this a step further, experiments using accelerated ageing were conducted to estimate the folding endurance loss rate in acidic versus neutralized samples of the same papers. The results showed that the acidic samples lost their strength rapidly, whereas the neutralized ones exhibited remarkable stability [28 p. 1083, fig. 7]. Additionally, it was found that the lower the pH (or the higher the acidity), the faster the hydrolysis of cellulose in the paper [11 p. 255, fig. 8]. Since Barrow's pioneering studies, this finding has been consistently confirmed. Acid hydrolysis of cellulose, the mechanism of glycosidic bond cleavage discussed earlier, is the fundamental chemical process responsible for the loss of mechanical strength in paper under acidic conditions.

Identifying the problem simultaneously provided its solution. *Deacidification*, by neutralizing the acidity of acidic papers, slows down the process of acid hydrolysis of cellulose, reducing the rate of mechanical strength loss and thereby extending the useful lifespan of acidic papers. Numerous deacidification methods have been proposed to achieve this goal, ranging from manual, time-consuming techniques used in small laboratories with minimal equipment [3]-[12]-[50-62] to automated mass deacidification processes requiring industrial-scale facilities [63-74].

The simplest and most widely used deacidification method, applied in most conservation laboratories worldwide, involves immersing paper in an aqueous solution of calcium hydroxide [3]-[62]. Calcium hydroxide is a base, reacting with and neutralizing the acids present in the paper.

The purpose of deacidification is twofold: to neutralize present acidity, and to deposit an alkaline buffer to guard against future acid accumulation. During the ageing process, the pH of paper gradually decreases due to the absorption of acidic pollutants from the atmosphere, the migration of acidic components from adjacent materials, and the

[13] The E_a values reported in the literature typically range between 80–120 kJ/mol.

formation of organic acids as the paper deteriorates [2]-[41]. The excess deacidifying agent, known as the *alkaline reserve*, will neutralize any future acidity that may develop. However, deacidification cannot reverse the ageing process, it can only slow it down from the moment of treatment onward. Additionally, it offers long-term protection, making it a method of chemical stabilization. Nevertheless, it cannot restore the lost mechanical strength of the paper.

B. Permanent Paper

The expansion of the deacidification concept led to the realization that newly manufactured paper intended for long-term stabiblity should be non-acidic and preferably, alkaline. This idea began to be gradually implemented in the paper industry from the 1980s onward.

Since the mid-18th century, with the industrialization of paper production, a new sizing system was introduced and replaced the traditional gelatin-based sizing system. This new system involved the use of potassium alum [$KAl(SO_4)_2 \cdot 12H_2O$] or later aluminum sulfate [$Al_2(SO_4)_3$] and a natural resin, rosin. Both aluminum sulfate and alum made paper acidic [8]-[75-78].

With growing awareness of the detrimental effects of high paper acidity, the industry began experimenting with new sizing systems that could function in alkaline conditions [79]. A major breakthrough came with the introduction of calcium carbonate as a filler material [4]-[8]-[80]. Calcium carbonate is a salt, but it has the important property of reacting with acids, forming calcium salts and carbon dioxide. This allows it to neutralize acids, functioning similarly to bases. Accelerated ageing tests demonstrated that calcium carbonate, in combination with modern non-acidic sizing systems, significantly enhances the chemical stability (*permanence*) of paper.

Furthermore, studies have shown that producing paper under alkaline conditions not only significantly extends its longevity but also reduces production costs, minimizes wear of manufacturing equipment, and results in a whiter final product [79]-[81]. Today, virtually all paper manufactured for writing and printing purposes is alkaline, containing calcium carbonate as a buffering agent. This paper typically has a pH between 7.5 and 10 and is classified as *permanent paper* due to its exceptional resistance to ageing, ensuring chemical and mechanical stability over extended periods [82]-[83].

The International Organization for Standardization (ISO) has established two key standards for paper longevity:

ISO 9706 [84] specifies the requirements for paper used in documents intended for permanent preservation. This type of paper must contain a minimum amount of calcium carbonate to ensure chemical and mechanical stability. The infinity symbol (∞) is used to designate paper that meets this standard.

ISO 11108 [85] applies to archival paper, meaning paper intended for frequent use and long-term preservation. This standard sets stricter requirements than ISO 9706, with a particular emphasis on the necessary mechanical strength to withstand handling over time.

C. pH of Materials Used for Long-Term Storage of Books and Archives

As discussed earlier, when cellulose is exposed to an acidic environment, its chains begin to break at random points through the process of acid hydrolysis [6]-[8]. This leads to a reduction in chain length, causing the gradual loss of paper strength over time [8]. The lower the pH, the faster the deterioration of paper strength. Experimental studies have also shown that during the ageing process, the pH of paper decreases [2]-[41] due to the generation of organic acids within the paper itself. Many of the byproducts of paper ageing are acidic gases or volatile compounds that behave like gases [86-89]. These substances can be absorbed by paper, meaning that direct contact between two sheets is not necessary for the transfer of acidic components. Simply coexisting in a closed or poorly ventilated space will eventually lead to the spread of acidity, accelerating the degradation process [90]-[91].

Accelerated ageing experiments conducted in sealed vessels have demonstrated that paper deteriorates significantly faster than in ovens with air renewal, confirming theoretical predictions. Furthermore, simply adding some alkaline paper to the ageing vessels resulted in a notable reduction in the ageing rate [27]-[89].

If acidic papers and cardboards, as well as glues and other materials, are used for the storage of archival materials and books, their volatile ageing byproducts will be transferred and absorbed by the original materials, accelerating their deterioration. However, even initially neutral papers tend to become acidic over time as they age [2]-[41]. Archival paper also undergoes progressive acidification during its lifespan. Therefore, if the papers and cardboards used for storage contain an *alkaline buffer*, there is potential for the neutralization of acids produced by the archival materials themselves. This alkaline buffer, typically calcium carbonate, offers dual protection by neutralizing acids produced during the ageing process of the stored material and shielding paper from acidic atmospheric pollutants [92].

Thus, the selection of appropriate storage materials not only provides passive mechanical protection but also actively contributes to the chemical preservation of archival materials, thereby significantly extending the lifespan of acidic and aged papers [93]. Conversely, acidic storage materials can rapidly degrade fragile archival documents, causing irreversible damage within a short period.

D. Evaluation of Paper Conservation Methods and Materials

Apart from deacidification, which aims at the chemical stabilization of paper and whose effectiveness was initially demonstrated using accelerated ageing methodology, there are numerous conservation interventions with various objectives. These include the chemical stabilization of both paper and a particularly corrosive type of ink (iron gall ink), disinfection, mending, the strengthening of mold-damaged and brittle paper, etc. [3].

Many of these methods are relatively new and have not yet stood the test of time. The same applies to many modern

synthetic materials. It is important to remember the destructive consequences of certain older conservation methods. In particular, the use of some synthetic resins (polymers) has caused irreversible damage, as their ageing behavior was not well understood at the time [94].

In current practice, before a new material or conservation method is adopted, its impact on the ageing rate of paper is thoroughly tested. Samples of treated paper (either subjected to the conservation method or treated with the new material under evaluation) undergo accelerated ageing tests alongside untreated control samples [1]-[17].

By comparing the ageing rates of treated and untreated samples, researchers can determine whether and how the tested method or material affects the degradation of paper. Such methods must be tested on multiple types of paper, including historical paper similar to the materials they are intended for. This approach has led to the rejection of several past conservation techniques and the adoption of improved methods and materials. Accelerated ageing can also be used for quality control and the optimization of conservation treatments in specific applications.

E. Effect of Temperature and Relative Humidity on the Ageing Rate of Paper - Storage Conditions

Chemistry demonstrates that an increase in temperature accelerates chemical reactions, a principle that also applies to the ageing of paper. Based on various published studies on artificial paper ageing [2]-[95]-[96] that followed the general methodology described earlier, Table IV was constructed. The relative ageing rates were calculated under the assumption that Ea equals 100 kJ. This value is representative of a paper grade exhibiting moderate stability. Using this assumption, the approximate relative ageing rates of this paper under different environmental conditions were estimated. The ageing rate at 20°C and 50% relative humidity (RH) was set to 1, and all other rates were calculated relative to this baseline.

***Table IV**: Relative ageing rates of a specific type of paper under various temperatures and relative humidities (50% and 75%). The calculation of these relative rates is based on the assumption that E_a equals 100 kJ, a value derived from a comparative study of multiple artificial ageing experiments on paper. [2]-[95-97].*

T (°C)	0	5	10	15	20	25	30	35	40	45	50
RH: 50%	0.05	0.11	0.23	0.49	**1.0**	2.0	3.9	7.4	13.7	25.1	45.1
RH: 75%	0.08	0.16	0.34	0.74	1.5	3.0	**5.8**	11.1	20.6	37.7	67.7

From Table IV, it is evident that a simultaneous increase in temperature by 10°C and relative humidity by 25%—shifting from 20°C and 50% RH to 30°C and 75% RH—leads to a nearly sixfold increase in the ageing rate. For example, a type of paper with a useful lifespan of 600 years at 20°C and 50% RH would have its lifespan reduced to approximately 100 years under 30°C and 75% RH conditions. From the perspective of natural ageing, maintaining lower temperatures and relative humidity levels significantly slows down the degradation process of paper.

Under conditions of low relative humidity and temperature (below 55-60% RH and 20-23°C), biological activity is also significantly reduced. Fungi, which pose the greatest threat, become inactive under these conditions, though they are not eradicated [98]. The activity of insects and rodents also declines. Controlling biological activity is another important reason for regulating the climatic conditions in storage areas [99].

However, relative humidity should not drop below 25%, as materials may become too dry, and if already in an advanced state of ageing, they may become brittle [100]. This sets a lower limit for relative humidity. Is there a lower limit for temperature as well? From a purely scientific perspective when considering the ageing rate, the answer is no. The minimum temperature for storage conditions is determined by many other factors, including economic, technical, and environmental [95].

Historic buildings, often used to house archives, libraries, and museums in Greece, other Mediterranean countries, and many regions worldwide, typically lack insulation and frequently exhibit structural defects. In other words, they are characterized by poor *building physics* [101] [14]. As suggested by Brokerhof et al. [101], "It is evident that it is impossible to control the climate inside buildings with a poor-quality building envelope, even with an advanced air treatment system. On the other hand, a building with high-quality building physics, barely requires climate control to create a stable climate inside. This is the starting point for sustainability."

Achieving low temperatures depends on the quality of the building physics, the local microclimate, and the financial resources available for installing and operating a climate control system. In hot climates, maintaining very low temperatures is both challenging and costly [102]. Additionally, it depends on the location of storage areas. Underground, specially constructed well-insulated spaces free from moisture tend to remain cool even during summer months, making the maintenance of low temperatures in such environments relatively cost-effective. Naturally, it is essential to ensure these spaces are fully protected against the risk of flooding.

Successful efforts have been made to maintain acceptable climatic conditions with appropriate building design and minimal use of electricity [103]. By relaxing the requirement for highly stable conditions all year round, stipulated by older standards (± 2°C and ± 5% RH), modern storage standards recommend a gradual shift in average temperature for energy conservation [104]-[105]. During winter, the average temperature can remain relatively low, while it can gradually increase as the warmer months

[14] The term "building physics" refers to the construction quality, the presence or absence of insulation, the quality and materials used, as well as the impermeability of walls, windows, roofing, and other elements that passively influence the stability and independence of internal climatic conditions from external ones. An example of poor building envelope quality could be a historic building lacking insulation, with single-glazed windows, and cracks or gaps in the masonry and window frames.

approach, up to a reasonable level suited to the local climate.

Modern standards, unlike older ones, do not prescribe fixed values with strict, minimal fluctuations in temperature and relative humidity [106]-[107]. Instead, they define acceptable ranges for these parameters and provide guidelines for selecting the most appropriate conditions for a specific cultural institution, considering among others financial, environmental, and climatic factors. For further details, interested readers are encouraged to consult the relevant literature and updated standards for archival, library, and museum storage environments [104]-[105]-[107-110].

VI. Epilogue

Accelerated ageing is a key tool for understanding the long-term implications of today's preservation decisions, choices that will significantly affect the future condition of our written cultural heritage. It provides a valuable means of assessing the effects of storage conditions and the relative merits of conservation treatments, particularly when long-term empirical data is unavailable.

The preceding discussion seeks to promote a clearer framework of communication between archivists, librarians, and conservators, with the aim of strengthening collaboration and enhancing the overall effectiveness of preservation strategies.

Beyond its technical objectives, this article is also intended to support understanding and dialogue across disciplines. It aims to make key scientific concepts, often found in the literature of conservation and preservation science, more accessible to professionals in archives and libraries. By presenting these ideas through simplified models and illustrative examples, it can serve as a useful reference for those involved in managing preservation strategies or evaluating related scientific publications.

In this way, the article contributes to interdisciplinary communication and training, helping bridge the gap between research and professional practice.

VII. References

[1] S. Zervos and A. Moropoulou, "Methodology and criteria for the evaluation of paper conservation interventions. Literature review", Restaurator, vol. 27, no. 4, pp. 219-274, 2006.

[2] S. Zervos, "Natural and accelerated ageing of cellulose and paper: A literature review", in "Cellulose: Structure and Properties, Derivatives and Industrial Uses", A. Lejeune and T. Deprez, Editors, Nova Publishing, New York. pp. 155-203, 2010.

[3] S. Zervos and I. Alexopoulou, "Paper conservation methods: a literature review", Cellulose, vol. 22, no. 5, pp. 2859-2897, 2015.

[4] J.C. Roberts, "The chemistry of paper", Cambridge, UK, The Royal Society of Chemistry, 1996.

[5] D. Hunter, "Papermaking, the history and technique of an ancient craft", New York, Dover Publications, Inc., 1974.

[6] D. Klemm, B. Philipp, T. Heinze, U. Heinze, and W. Wagenknecht, "Comprehensive cellulose chemistry. Fundamentals and analytical methods", Vol. 1. Weinheim, Wiley - VCH, 1998.

[7] A.L. Andrady, Y. Song, R. Parthasarathy, K. Fueki, and A. Torikai, "Photoyellowing of mechanical pulp. Part 1: Examining the wavelength sensitivity of light-induced yellowing using monochromatic radiation", TAPPI Journal, vol. 74, no. 8, pp. 162-168, 1991.

[8] N. Gurnagul, R.C. Howard, X. Zou, T. Uesaka, and D.H. Page, "The mechanical permanence of paper: a literature review", Journal of Pulp and Paper Science, vol. 19, no. 4, pp. j160-j166, 1993.

[9] X. Zou and N. Gurnagul, "The role of lignin in the mechanical permanence of paper: Part II. Effect of acid groups", Journal of Wood Chemistry and Technology, vol. 15, no. 2, pp. 247-262, 1995.

[10] X. Zou, N. Gurnagul, and T. Uesaka, "The role of lignin in the mechanical permanence of paper. Part I: effect of lignin content", Journal of Pulp and Paper Science, vol. 19, no. 6, pp. j235-j239, 1993.

[11] X. Zou, T. Uesaka, and N. Gurnagul, "Prediction of paper permanence by accelerated aging I. Kinetic analysis of the aging process", Cellulose, vol. 3, pp. 243-267, 1996.

[12] F. Daniel, F. Flieder, and F. Leclerc, "The effects of pollution on deacidified paper", Restaurator, vol. 11, no. 3, pp. 179-207, 1990.

[13] J.B.G.A. Havermans, "Effects of air pollutants on the accelerated aging of cellulose-based materials", Restaurator, vol. 16, no. 4, pp. 209-233, 1995.

[14] N. Valentin, R. Garcia, O. De Luis, and S. Maekawa, "Microbial control in archives, libraries and museums by ventilation systems", Restaurator, vol. 19, no. 2, pp. 85-107, 1998.

[15] A. Mosca Conte, O. Pulci, A. Knapik, J. Bagniuk, R. Del Sole, J. Lojewska, and M. Missori, "Role of Cellulose Oxidation in the Yellowing of Ancient Paper", Physical Review Letters, vol. 108, no. 15, pp. 158301, 2012.

[16] ISO 5630-3 (1996) "Paper and board - Accelerated ageing. Part 3: Moist heat treatment at 80 ºC and 65% relative humidity".

[17] S. Zervos, "Evaluating treatments of paper using statistically valid test methods. Part II: Experimental setup and protocol", Restaurator, vol. 28, no. 4, pp. 256-288, 2007.

[18] K.W. Wilson and E.J. Parks, "Comparison of accelerated aging of book papers in 1937 with 36 years natural aging", Restaurator, vol. 4, pp. 1-55, 1980.

[19] W.K. Wilson and E.J. Parks, "Historical survey of research at the National Bureau of Standards on materials for archival records", Restaurator, vol. 5, pp. 191-241, 1983.

[20] C. Fellers, T. Iversen, T. Lindstrom, T. Nilsson, and M. Rigdahl, "Ageing/degradation of paper, a literature survey", in FoU-projektet for papperskonservering, FoU-projektet for papperskonservering, Stockholm, 1989.

[21] A.M. Emsley and G.C. Stevens, "Kinetics and mechanisms of the low-temperature degradation of cellulose", Cellulose, vol. 1, pp. 26-56, 1994.

[22] ASTM D 1795 (R2021) "Standard test method for intrinsic viscosity of cellulose".

[23] H.D. Burgess, "Gel permeation chromatography. Use in estimating the effect of water washing on the long-term stability of cellulosic fibers", in "Historic textile and paper materials. Conservation and characterization", H.L. Needles and S.H. Zeronian, Editors, American Chemical Society, Washington, DC. pp. 363-376, 1986.

[24] X. Zou, N. Gurnagul, T. Uesaka, and J. Bouchard, "Accelerated aging of papers of pure cellulose: mechanism of cellulose degradation and paper embrittlement", Polymer Degradation and Stability, vol. 43, pp. 393-402, 1994.

[25] R.L. Feller, S.B. Lee, and J. Bogaard, "The kinetics of cellulose deterioration", in "Historic textile and paper materials. Conservation and characterization", H.L. Needles and S.H. Zeronian, Editors, American Chemical Society, Washington, DC. pp. 329-347, 1986.

[26] ISO 5626 (1993) "Paper - Determination of folding endurance".

[27] C.J. Shahani "Accelerated aging of paper: Can it really foretell the permanence of paper", Preservation Research and Testing Series, 9503, 1995

[28] W.J. Barrow and R.C. Sproull, "Permanence in book papers", Science, vol. 129, pp. 1075-1084, 1959.

[29] G.G. Gray, "An accelerated-aging study comparing kinetic rates vs. TAPPI Standard 453", TAPPI Journal, vol. 52, no. 2, pp. 325-334, 1969.

[30] D.D. Roberson, "Permanence/ durability and preservation. Research at the Barrow laboratory", in "Preservation of paper and textiles of historic and artistic value II", J.C. Williams, Editor, American Chemical Society, Washington, DC. pp. 45-55, 1981.

[31] H. Bansa, "Accelerated ageing of paper: Some ideas on its practical benefit", Restaurator, vol. 23, no. 2, pp. 106-117, 2002.

[32] H.-Z. Ding and Z.D. Wang, "Time–temperature superposition method for predicting the permanence of paper by extrapolating accelerated ageing data to ambient conditions", Cellulose vol. 14, no. 3, pp. 171–181, 2007.

[33] B. Havlínová, S. Katuščák, M. Petrovičová, A. Maková, and V. Brezová, "A study of mechanical properties of papers exposed to various methods of accelerated ageing. Part I. The effect of heat and humidity on original wood-pulp papers", Journal of Cultural Heritage, vol. 10, no. 2, pp. 222-231, 2009.

[34] ISO 5630-1 (1991) "Paper and board - Accelerated ageing. Part 1: Dry heat treatment at 105 ºC".

[35] ISO 5630-2 (1985) "Paper and board - Accelerated ageing. Part 2: Moist heat treatment at 90 ºC and 25% relative humidity (Withdrawn)".

[36] M. Jablonský, M. Botkova, and K. Hroboňová, "Accelerated ageing of wood-containing papers: Formation of weak acids and deterioration of tensile strength", Wood Research, vol. 57, no. 3, pp. 419-434, 2012.

[37] M. Jablonský, J. Kazíkova, M. Botkova, and S. Holúbková, "Kinetic dependences for the decrease of polymerization of paper undergoing accelerated ageing", Cellulose Chemistry and Technology, vol. 46, no. 9-10, pp. 625-630, 2012.

[38] K.L. Kato and R.E. Cameron, "A review of the relationship between thermally-accelerated ageing of paper and hornification", Cellulose, vol. 6, pp. 23-40, 1999.

[39] K. Lee and M. Inaba, "Accelerated Ageing Test of Naturally Aged Paper（Part IV）: Effect of Humidity, Amount of Oxygen and of Organic Acids on the Degradation of Paper in Sealed Tube Method", Japan TAPPI Journal, vol. 71, no. 10, pp. 1204-1214, 2017.

[40] K. Vizárová, S. Kirschnerová, F. Kačík, A. Briškárová, Š. Šutý, and S. Katuščák, "Relationship between the decrease of degree of polymerisation of cellulose and the loss of groundwood pulp paper mechanical properties during accelerated ageing", Chemical Papers, vol. 66, no. 12, pp. 1124-1129, 2012.

[41] W.K. Wilson, J.L. Harvey, J. Mandel, and T. Worksman, "Accelerated aging of record papers compared with normal aging", TAPPI Journal, vol. 38, no. 9, pp. 543-548, 1955.

[42] E. Kaminska, P. Bégin, D. Grattan, D. Woods, and A. Bülow, "ASTM/ISR research program on the effects of aging on printing and writing papers: Accelerated aging test method development", Canadian Conservation Institute, 2001.

[43] B. Browning and W. Wink, "Studies on the permanence and durability of paper - I. Prediction of paper permanence", TAPPI Journal, vol. 51, no. 4, pp. 156-163, 1968.

[44] G.G. Gray, "Determination and significance of activation energy in permanence tests", in "Preservation of paper and textiles of historic and artistic value", J.C. Williams, Editor, American Chemical Society, Washington, DC. pp. 286-313, 1977.

[45] J.S. Arney and A.H. Chapdelaine, "A kinetic study of the influence of acidity on the accelerated aging of paper", in "Preservation of paper and textiles of historic and artistic value II", J.C. Williams, Editor, American Chemical Society, Washington, DC. pp. 189-204, 1981.

[46] N.S. Baer and N. Indictor, "Use of the Arrhenius equation in multicomponent systems", in "Preservation of paper and textiles of historic and artistic value", J.C. Williams, Editor, American Chemical Society, Washington, DC. pp. 336-351, 1977.

[47] D.D. Roberson, "The evaluation of paper permanence and durability", TAPPI Journal, vol. 59, no. 12, pp. 63-69, 1976.

[48] E. Strofer-Hua, "Experimental measurement: Interpreting extrapolation and prediction by accelerated aging", Restaurator, vol. 11, no. 4, pp. 254-266, 1990.

[49] H. Porck, "Rate of paper degradation. The predictive value of artificial aging tests", European Commission on Preservation and Access, Amsterdam, 2000.

[50] M. Hey, "The washing and aqueous deacidification of paper", The Paper Conservator, vol. 4, pp. 66-79, 1979.

[51] D. Mihram, "Paper deacidification: A bibliographic survey - Part I", Restaurator, vol. 7, no. 2, pp. 81-98, 1986.

[52] D. Mihram, "Paper deacidification: A bibliographic survey - Part II", Restaurator, vol. 7, no. 3, pp. 99-118, 1986.

[53] A. Lienardy and P. Van Damme, "Practical deacidification", Restaurator, vol. 11, no. 1, pp. 1-21, 1990.

[54] L.R. Green and M. Leese, "Nonaqueous deacidification of paper with methyl magnesium carbonate", Restaurator, vol. 12, no. 3, pp. 147-162, 1991.

[55] J. Kolar and G. Novak, "Effect of various deacidification solutions on the stability of cellulose pulps", Restaurator, vol. 17, no. 1, pp. 25-31, 1996.

[56] H. Bansa, "Aqueous deacidification - with calcium or with magnesium", Restaurator, vol. 19, no. 1, pp. 1-40, 1998.

[57] J.W. Baty, C.L. Maitland, W. Minter, M.A. Hubbe, and S.K. Jordan-Mowery, "Deacidification for the conservation and preservation of paper-based works: A review", BioResources, vol. 5, no. 3, pp. 1955-2023, 2010.

[58] J. Bogaard, H.R. Morris, and P.M. Whitmore, "A method for the aqueous deacidification of oxidized paper", Journal of the American Institute for Conservation, vol. 44, no. 2, pp. 63-74, 2005.

[59] G. Poggi, N. Toccafondi, L.N. Melita, J.C. Knowles, L. Bozec, R. Giorgi, and P. Baglioni, "Calcium hydroxide nanoparticles for the conservation of cultural heritage: new formulations for the deacidification of cellulose-based artifacts", Applied Physics A, vol., pp. 1-9, 2013.

[60] A. Wójciak, "Washing, Spraying and Brushing. A Comparison of Paper Deacidification by Magnesium Hydroxide Nanoparticles", Restaurator, vol. 36, no. 1, pp. 3-23, 2015.

[61] H. Fan, M. Guo, H. Mou, J. Liu, and J. Li, "Extending the Durability of Old Books by Atomized Deacidification and Reinforcement Treatments", BioResources, vol. 15, no. 1, pp. 276-289, 2020.

[62] I. Alexopoulou and S. Zervos, "Paper conservation methods: An international survey", Journal of Cultural Heritage, vol. 21, pp. 922-930, 2016.

[63] R.D. Smith, "Non-aqueous deacidification: Its philosophies, origin, development and status", The Paper Conservator, vol. 12, pp. 31-34, 1988.

[64] A. Lienardy, "A bibliographical survey of mass deacidification methods", Restaurator, vol. 12, no. 2, pp. 75-103, 1991.

[65] A. Lienardy, "Evaluation of seven mass deacidification treatments", Restaurator, vol. 15, no. 1, pp. 1-25, 1994.

[66] J.B.G.A. Havermans, R. Van Deventer, and T. Steemers, "Mass deacidification of archival materials using diethyl zinc", Restaurator, vol. 16, no. 3, pp. 123-142, 1995.

[67] H.J. Porck, "Mass Deacidification. An Update on Possibilities and Limitations", European Commission on Preservation and Access, Amsterdam; Commission on Preservation and Access, Washington, DC, 1996.

[68] A. Blüher and B. Vogelsanger, "Mass Deacidification of Paper", CHIMIA, vol. 55, no. 11, pp. 981-989, 2001.

[69] H. Cheradame, S. Ipert, and E. Rousset, "Mass deacidification of paper and books. I: Study of the limitations of the gas phase processes", Restaurator, vol. 24, no. 4, pp. 227-239, 2003.

[70] E. Rousset, S. Ipert, and H. Cheradame, "Mass deacidification of paper and books II: Deacidification in the liquid phase using aminosilanes", Restaurator, vol. 25, no. 2, pp. 104-118, 2004.

[71] G. Banik, "Mass deacidification technology in Germany and its quality control", Restaurator, vol. 26, no. 1, pp. 63-75, 2005.

[72] M. Stumpf, "Mass deacidification at the North Rhine-Westphalia Archives—experience with the Neschen process", in "Save paper", A. Blüher and G. Grossenbacher, Editors. pp. 43-57, 2006.

[73] J. Adams, "Mass Deacidification Annotated Bibliography 1990-2010", Library of Congress. Preservation Directorate, Washington, DC, 2011.

[74] K. Ahn, U. Henniges, A. Blüher, G. Banik, and A. Potthast, "Sustainability of mass deacidification. Part I: Concept, selection of sample books and pH-determination", Restaurator, vol. 32, no. 3, pp. 193-222, 2011.

[75] I. Brückle, "The role of alum in historical papermaking", Abbey Newsletter, vol. 17, no. 4, 1993.

[76] H. El-Saied, A.H. Basta, and M.M. Abdou, "Permanence of paper 1: Problems and permanency of alum-rosin sized paper Sheets from wood pulp", Restaurator, vol. 19, no. 3, pp. 155-171, 1998.

[77] A.H. Basta, H. El-Saied, S.H. Mohamed, and S. El-Sherbiny, "The role of neutral rosin-alum size in the production of permanent paper", Restaurator, vol. 27, no. 2, pp. 67-80, 2006.

[78] S.Y. Lee, J. Baty, and W. Minter, "Study of the aging behavior of rosin-alum sized papers by analysis of mechanical strength, optical properties, and

chemical composition following accelerated aging", The Book and Paper Group Annual, vol. 29, pp. 127-128, 2010.

[79] B.W. Crouse and D.G. Wimer, "Alkaline papermaking: an overview", TAPPI Journal, vol. 74, no. 7, pp. 152-159, 1991.

[80] R.W. Hagemeyer and L.J. Welch, "Natural calcium carbonate for alkaline paper", Tappi Journal, vol. 64, no. 5, pp. 97-100, 1981.

[81] D.P. Paiste, "Considerations for Alkaline papermaking", Tappi Journal, vol. 64, no. 4, pp. 97-100, 1981.

[82] ANSI/NISO Z39.48 (R1997) "Permanence of paper for publications and documents in libraries and archives".

[83] A.C. Sclawy and J.C. Williams, "Alkalinity - the key to paper permanence", Tappi Journal, vol. 64, no. 5, pp. 49-50, 1981.

[84] ISO 9706 (1994) "Information and documentation - Paper for documents. Requirements for permanence".

[85] ISO 11108 (1996) "Information and documentation - Archival paper. Requirements for permanence and durability".

[86] J.B.G.A. Havermans, "Ageing behavior of encapsulated paper", Restaurator, vol. 20, no. 2, pp. 108-115, 1999.

[87] C. Shahani, S.B. Lee, F.H. Hengemihle, G. Harrison, P. Song, M.L. Sierra, C.C. Ryan, and N. Weberg, "Accelerated aging of paper: I. Chemical analysis of degradation products. II. Application of Arrhenius relationship. III. Proposal for a new accelerated aging test: ASTM research program into the effect of aging on printing and writing papers", Library of Congress, Washington, DC, 2001.

[88] C.J. Shahani and G. Harrison. "Spontaneous formation of acids in the natural aging of paper", in Works of Art on paper, books, documents and photographs. Techniques and conservation. Congress of the International institute for Conservation. Baltimore, MD, 2002.

[89] S. Zervos and A. Moropoulou, "Cotton cellulose ageing in sealed vessels. Kinetic model of autocatalytic depolymerization", Cellulose, vol. 12, no. 5, pp. 485-496, 2005.

[90] A. Bulow, P. Begin, H. Carter, and T. Burns, "Migration of volatile compounds through stacked sheets of paper during accelerated ageing. Part II: Variable temperature studies", Restaurator, vol. 21, no. 4, pp. 187-203, 2000.

[91] H. Carter, P. Begin, and D. Grattan, "Migration of volatile compounds through stacked sheets of paper during accelerated aging - Part 1 : Acid migration at 90° C", Restaurator, vol. 21, no. 2, pp. 77-84, 2000.

[92] P. Begin, S. Deschatelets, D. Grattan, N. Gurnagul, J. Iraci, E. Kaminska, D. Woods, and X. Zou, "The effect of air pollutants on paper stability", Restaurator, vol. 20, no. 1, pp. 1-21, 1999.

[93] J.H. Hofenk de Graaff, W.G.T. Roelofs, and H. Van Keulen, "The effect of alkaline boxes and file folders on the accelerated ageing of paper by air pollution", Janus, vol. 2, pp. 102-109, 1996.

[94] D. Aubier, J.M. Blengino, A.C. Brandt, and N. Silvie, "Degradation caused by cellulose diacetate: Analysis and proposals for conservation treatment", Restaurator, vol. 17, no. 2, pp. 130-143, 1996.

[95] W.K. Wilson, "Environmental guidelines for the storage of paper records (NISO TR01-95)", National Information Standards Organization, Bethesda, MD, 1995.

[96] E.L. Graminski, E.J. Parks, and E.E. Toth, "The effects of temperature and moisture on the accelarated ageing of paper", in "Durability of macromolecular materials", R.K. Eby, Editor, American Chemical Society, Washington, DC. pp. 341-355, 1979.

[97] I. Alexopoulou and S. Zervos, "Paper conservation methods: An international survey", Journal of Cultural Heritage, vol.

[98] M. Nitterus, "Fungi in archives and libraries", Restaurator, vol. 21, no. 1, pp. 25-40, 2000.

[99] R.D. Smith, "Fumigation quandary: More overkill or common sense?", The Paper Conservator, vol. 10, pp. 46-47, 1986.

[100] A.C. Sclawy, "The effect of varying relative humidity conditions on the folding endurance of aged paper samples", in "Preservation of paper and textiles of historic and artistic value II", J.C. Williams, Editor, American Chemical Society, Washington, DC. pp. 217-222, 1981.

[101] A.W. Brokerhof, H.A. Ankersmit, and F.J. Ligterink, "Risk management for collections", Amersfoort, Rijksdienst voor het Cultureel Erfgoed, 2016.

[102] J. Rhys-Lewis, "The Maintenance of Archive Collections in Times of Constricting Budgets: Some Alternative Approaches under Development on the UK", Atlanti, vol. 26, no. 2, pp. 105-112, 2016.

[103] H. Stehkamper, "Natural air conditioning of stacks", Restaurator, vol. 9, pp. 163-177, 1988.

[104] PD 5454 (2012) "Guide for the storage and exhibition of archival materials".

[105] BS EN 16893 (2018) "Conservation of Cultural Heritage – Specifications for Location, Construction, and Modification of Buildings or Rooms Intended for the Storage or Use of Heritage Collections".

[106] J. Bickersteth, "Environmental conditions for safeguarding collections: What should our set points be?", Studies in Conservation, vol. 59, no. 4, pp. 218-224, 2014.

[107] S. Michalski, "Climate Guidelines for Heritage Collections: Where We Are in 2014 and How We Got Here", in Proceedings of the Smithsonian Institution. Summit on the Museum Preservation Environment. pp. 7-33, 2016.

[108] C. Baars, "Collection care and conservation", in "The Curation and Care of Museum Collections", B.

Campbell and C. Baars, Editors, Routledge, London. pp. 169-202, 2019.
[109] American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE), "ASHRAE Handbook – HVAC Applications, Chapter 23: Museums, Libraries, and Archives", ASHRAE, 2019.
[110] ISO 11799 (2015) "Information and documentation — Document storage requirements for archive and library materials".

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Decorated papers in bookbinding: A proposal for the creation of metadata for its documentation

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Abstract:

Purpose

The purpose of this study is the formulation of a metadata schema that represents the structure, methods, materials and designs of bookbinding found in 19th century books. The creation of a metadata schema contributes to systematizing the information collected regarding bookbinding guides and organizes the information collection and management process and facilitates search and retrieval. For each individual element of the binding process, the corresponding metadata are defined. The proposed metadata schema focuses on the representation of decorated papers used in books as covers, or parts of covers, and as endpapers. Mapping of metadata elements to Dublin Core elements is also provided, to facilitate standardization and interoperability.

Methodology

To achieve systematic documentation of the decorated papers and define a comprehensive and complete set of metadata, the first step was to categorize them and identify their properties. Initially, the techniques, materials, types of designs, colours, and characteristics of the papers were studied. To this end, information from similar categorizations was sourced from literature and the internet and utilized. Best practices followed by international standards for defining metadata and types of information encoding using controlled vocabularies and rules were identified and adopted.

Findings

This study presents a set of comprehensive and organized metadata elements for decorated papers, which can be used for the study and documentation of decorated papers.

Value

Today, in Greece, there have been only a few sporadic references to decorated papers, however no organized recording or systematic classification of these papers and their attributes is available. The present study constitutes the first step towards creating a metadata schema that will enable the recording, organization, management, and utilization of decorated paper information, as well as a populated database, aiming to deepen the understanding of book collection, correlate it with the spatial-temporal context of its use, and promote and disseminate the material to user communities.

Index Terms *— Decorated paper, marble paper, paste paper, coloured paper, embossed paper, printed paper, sprinkled paper, surface paper, metadata.*

I. INTRODUCTION

Joseph William Zaehnsdorf (1853-1930) in his book *The Art of Bookbinding: a Practical Treatise* [1] states that a bookbinding is completed in two basic stages. The first stage (forwarding) involves creating the book as a body and includes sewing the gatherings, gluing and rounding the spine, placing the endbands, attaching the boards, and covering the book with a material such as fabric, leather, parchment, paper, or a combination of these. The second stage (finishing) is the decoration of the cover. Decoration refers to the embellishment of the cover with various designs and techniques, such as printed (embossed, blind-embossed) decoration, gold or silver stamping, insertion of metallic elements, and impressions of lettering on the spine or both sides of the cover.

For the creation of an aesthetically pleasing result, whether for a handmade or industrially produced book, in addition to the final decoration, the following factors play a crucial role:

- The choice of cover material, its quality, colour, and texture.
- The choice or execution of headbands (handmade or industrial) which usually aesthetically match the cover's colour.
- Decoration of the edges using various techniques (marbling, gilding, colouring, embossing, etc.).
- The use of decorated papers with various techniques, used as endpapers or cover materials, either alone or in combination with other cover materials such as leather and fabric [2].

In researching 19th-century bookbinding in Greek libraries the striking decorated papers used attracted further study and it soon became evident that very few references to the topic existed. Occasionally, records of the papers were made by librarians, bookbinders, and especially book

conservators, who document binding elements as part of the conservation process. However, organized recording and classification of the papers had not been carried out.

Decorated papers are handmade or industrial papers that have undergone special treatment to be used in bookbinding as cover, or part of cover or endpapers. At t times they also have decorated boxes for storing books and objects (such as children's toys) or small furniture [3]. Furthermore, they have been used as recycled material for lining the spines of books. In addition, they served as substrates for printing and penmanship as well as wrapping papers [4].[1]

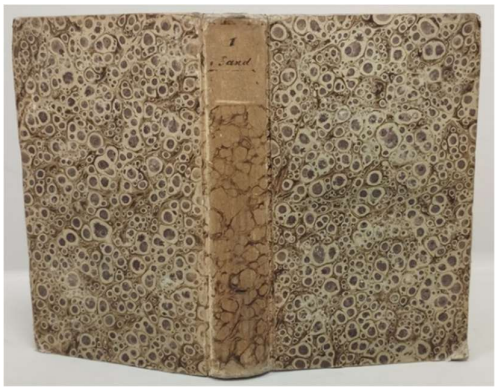

Fig. 1. *Decorated paper as book cover*

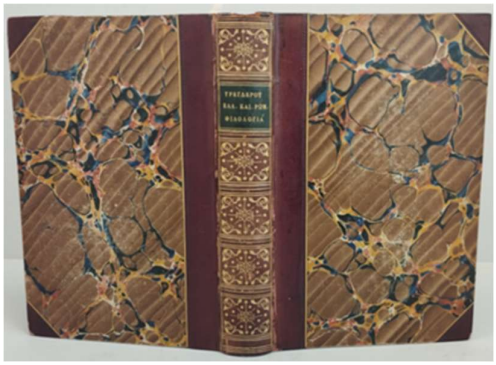

Fig. 2. *Decorated paper as part of the book cover*

Decorated papers are used in various types of bookbinding as cover (Fig. 1), for decorative reasons as well as for economy, since, for example, leather is much more expensive than decorated paper, which a bookbinder can easily create in his workshop. They may cover the entire cover or part of it (Fig. 2). Depending on the section that they occupy on the cover, bindings are classified as (Fig. 3):

- Full binding,
- Half binding,
- Quarter binding,
- Three-quarter binding.

Decorated papers are also used as endpapers (Fig. 4). Endpapers (endleaves) are two sheets of paper placed, one at the beginning and one at the end of the text block. In addition to decorated papers, plain white sheets are sometimes used for endpapers, often made from the same paper as the text block. Of these, the leaves that are glued to the front and back boards are called pastedowns, whereas the remaining ones are called flyleaves. For the description of the term various names have been used such as "παράφυλλα", "ακρόφυλλα" even "φύλακες" (guards) of the book as they protect the text block from damages [5]-[6].

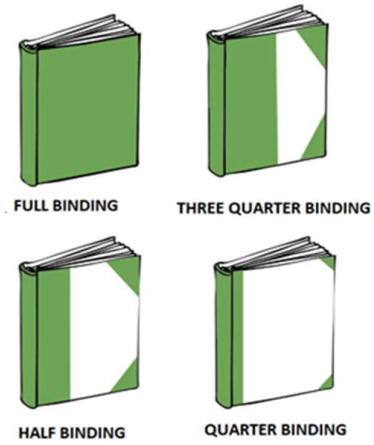

Fig. 3. *Binding types*

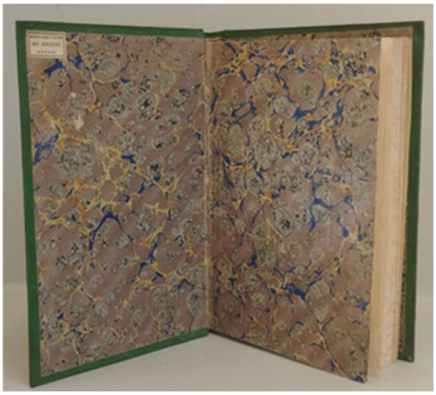

Fig. 4*. Decorated papers as endleaves of the book.*

II. Research Methodology

Documenting the decorated papers is a challenge due to the uniqueness of each case and the lack of standardization of the terminology used to describe them. Since no organized classification of the papers into categories has been done so far, the need for one arose, to facilitate research, identification of the papers, and the definition of metadata. More specifically, this classification will allow metadata to be entered into a database designed for the documentation, organization, management, and display of books in general, and decorated papers specifically found within them.

The first step was to catalogue the varieties of decorated paper and to this end a review of exceptional bookbinding samples found in the libraries of the Greek Parliament, the Panteion University of Social and Political Sciences, and the Kaireios Library of Andros[2], was carried out. The results were then crosschecked to existing samples and descriptions in relevant bibliography. The corpus of collected types of

[1] https://www.ligatus.org.uk/lob/concept/1285

[2] The aforementioned libraries were selected due to their exceptional collections in terms of bookbinding.

decorated papers leads to the search for methods of classification and management of the terminology for describing them.

After studying the bibliographic references, [2]-[4]-[7]-[8]-[9]-[10]-[11]-[12]-[13]-[14]-[27], it became clear that there is no common way to classify decorated papers, particularly marbled papers. Classification can be based on the technique used, but the names of the papers vary and are defined according to the creation technique or various cultural or historical influences.

It was decided that the criterion for classifying them would be the technique used in their creation, whereas the collection of data for formulating a rule for the recording of metadata would be based on the study of techniques, materials, types of patterns and designs, colours, and specific characteristics of the paper.

For the informational description of decorated papers, the internationally recognized Dublin Core™ Metadata Initiative standard[3] [15] was studied and used. This standard defines the minimal elements of information that can be used to describe web-based sources containing cultural information. The elements it proposes, and their specifications comprehensively describe the object being documented and its elements. Additionally, it is a simple standard that can be used even by non-experts in documentation. Furthermore, it supports interoperability and can be extended in the future by combining elements drawn from other standards without affecting it [16]- [17].

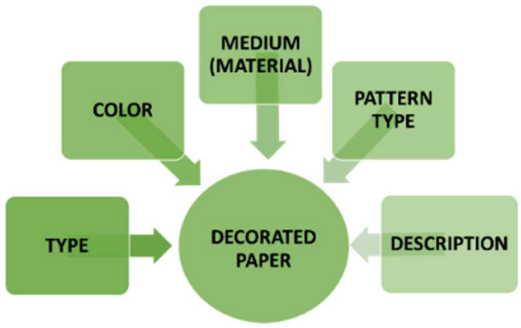

Fig. 5. *Elements for the documentation of decorated papers*

Another reason for choosing this standard is that it "supports the demands of broad usage and access over detailed analysis and exhaustive documentation"[17], which is the goal in this specific case.

The design of this documentation proposal aims to capture the minimum set of elements that describe each decorated paper. These elements include the type, pattern, colour, and paper quality, which help to more accurately define the visual, digital documentation (digital copy of the decorated papers) (Fig. 5).

The elements that are used fall into the three categories prescribed by Dublin Core, which are as follows:

1. Content: Elements that describe the object.
2. Intellectual Property: Elements that describe copyright and creation.
3. Snapshot: Elements that describe the status and management of the object at a specific point in time (TABLE I).

Similarly to the approach followed by the Dublin Core standard, in the proposed metadata schema the elements are optional and repeatable [16] [17].

Based on the above, the recording of types of papers was designed.

Table I. *Dublin Core Elements*

	DCMI Element	Element Refinement(s)	Category
1	TITLE		Content
2	SUBJECT		
3	DESCRIPTION		
4	SOURCE		
5	LANGUAGE		
6	RELATION	Is Version Of Has Version Is Replaced By Replaces Is Required By Requires Is Part Of Has Part Is Referenced By References Is Format Of Has Format	
7	COVERAGE	Spatial/ Temporal	
8	PUBLISHER		Intellectual Property
9	CREATOR		
10	CONTRIBUTOR		
11	RIGHTS		Snapshot
12	DATE	Created Valid Available Issued Modified	
13	TYPE		
14	FORMAT	Extent Medium	
15	IDENTIFIER		

III. TYPES OF DECORATED PAPERS

The types of papers that decorate bookbinding vary and are classified into the following categories, based on references in literature and online sources, and according to the technique used to create them [2]- [19]- [12][4].

A. Paste Paper
B. Surface Paper
C. Coloured Paper

[3] It is a set of 15 terms that were proposed following the collaboration of an international team with library managers, museums, government programs, and commercial publishers with the World Wide Web Consortium (W3C). It was recognized as the IETF RFC 5013 standard, ANSI/NISO Standard Z39.85-2007, and ISO Standard 15836:2009**[16].**

[4] Endpapers | Rare Books & Manuscripts (adelaide.edu.au)

D. Marbled Paper
F. Printed Paper
G. Sprinkled Paper
H. Embossed Paper

Below, the fundamental techniques and subcategories associated with the variations in the final design of the paper are analysed.

A. Paste Paper (starch paste-coated paper)

Paste papers have been used since the late 16th century and continue to be used today as endpapers, book covers and part of book cover. They are created using various techniques, but the simplest involves coating the paper surface with a thick mixture of paste made from starch or flour paste, soap, and pigment.

Before the paste layer dries, various patterns are painted using a comb, fingers, a blunt tool, a brush, etc., to achieve striped, checkered, and other patterns that leave lighter areas of the paper exposed. (*Drawn/Combed paste*) (Fig. 6).

Fig. 6. *Drawn /Combed paste papers*

Another simple way to create a decorative pattern is by using a sponge, which, through gentle dabbing, leaves a random effect of different colour tones (*Daubed paste*) (Fig. 7).

Alternatively, two prepared sheets with paste and pigments can be placed with their coloured surfaces facing each other and then separated, creating a wavy pattern (*Pulled paste paper*) (Fig. 8).

Additionally, the paper can be decorated with a wooden block featuring embossed designs, which is pressed onto the paper surface. In the raised areas of the block, the paper appears lighter. Instead of a wooden block, bookbinding tools (fillets and rolls) can be used to imprint their designs on the coated paper (*Printed paste paper*) (Fig. 9).

Finally, the paper can be covered with diluted paste, creating random patterns, and then hung from one side so that the runny paste flows down, forming spontaneous gradations (*Spatter or brushed paste paper*) [20] (Fig. 10).

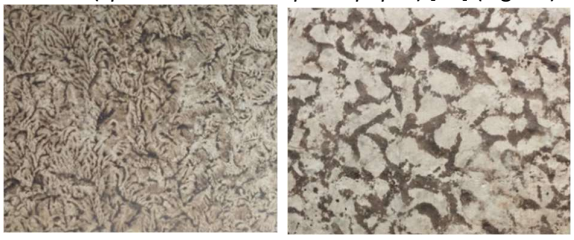

Fig. 7. *Daubed paste papers*

Fig. 8. *Pulled paste papers.*

Fig. 9. *Printed paste papers*

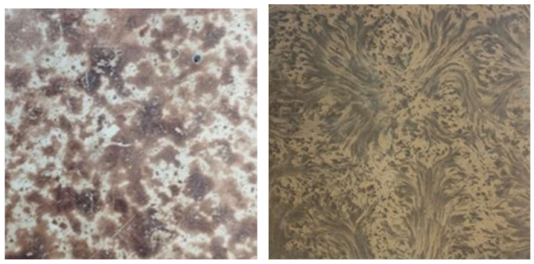

Fig. 10. *Brushed or spatter paste papers*

Once the design is created, the paper is left to dry at room temperature and is then polished with a hot iron. A paper may be created using a combination of two techniques [1]-[2]-[19].

Paste papers are unique and original, as there aren't patterns exactly alike. They were made using common, inexpensive materials and required minimal expertise from the maker, meaning that bookbinders and publishers could easily produce their own papers. This made them a cheap and easy choice for small print runs and for cases where more expensive decorated papers were unaffordable. As a result, very few recipes were recorded, and the papers were almost always unsigned [3].

B. Marbled Paper

Marbled papers are named for their surface patterns, which resemble the veins and designs found in marble. (Fig. 11) It is believed that the Persians were the first to use marbled paper for decorating manuscripts, as examples have been found in the margins of 16th-century manuscripts [3]-[8]-[19].

This technique was introduced to Western Europe from the East (via the Ottoman Turks) and began to be used in bookbinding from the late 16th or early 17th century [1]-[3].

This type of paper decoration is believed to have existed in Japan under the name *Suminagashi* since 1118. One theory (proposed by Lord Bacon) suggests that the marbling technique originated with the Turks. However, C.W.

Woolnough [7] believed that the art developed in the Netherlands around 1598. He suggested that small packages of Dutch toys arrived in England wrapped in marbled papers, likely to avoid English taxes. These papers were flattened and reused by bookbinders. The Dutch are also considered the first to use marbling techniques on the edges of books [1]-[3]-[19].

Another theory suggests that the Germans discovered the technique, as marbled paper has been found in *Alba Amicorum* (friendship album) [5] belonging to German travellers from 1575. In a later reference, Woolnough stated that he had found Turkish marbled paper in an album from 1616. It is possible that the Dutch, Germans, and Turks discovered the technique simultaneously but independently [19]-[20].

Marbled papers were created by spraying prepared colours onto a bath containing a solution of gum tragacanth and water. The colours were ground finely on a stone and mixed with water and a few drops of ox gall. If the pigments were organic based (lac colours), they were added directly. However, if they were mineral-based, a sticky substance was needed to prevent the heavy pigments from sinking. The best binding agents included diluted fish glue or parchment glue combined with gum tragacanth or even gum Arabic. Once the colours were prepared, droplets were sprinkled onto the solution's surface.

To create patterns, the artisan used various tools to manipulate the floating colours before placing the paper onto the bath. The colours adhered to the paper, creating the final design [25].

Once dried, the paper was polished with bee wax or soap to enhance its sheen and prevent it from sticking. For a higher gloss, the paper was burnished with flint or glass on a concave table. Later, hot rollers were used for this task.

Marbled papers were then coated with a mixture of animal glue, diluted in water, and a high-quality white soap. The mixture was left overnight over low heat before being applied to the paper. Polishing followed, using the methods described above [1].

The marbling process required precise measurements of ingredients (such as ox gall) and was sensitive to impurities in the water and changes in air temperature.

Each marbled paper is unique, as only one sheet can be produced at a time. Although the same colours can be reused for another sheet, the design and colour intensity will always be slightly different [3].

Fig. 11. *Image of Greek marbles 'Roches de Milo- at "M. Guizot, Expedition scientifique de Moree 1831-1835: travaux de la section des sciences physiques. Atlas. Paris: Chez F. G. Levrault, 1835, PL: XI" [34].*

Tanselle [2] suggesting categorizing marbled papers into two main groups based on whether the floating colours were manipulated or left untouched:

A. *Whisked:* If the colours remained as they fell into the bath, the designs were irregular, separated by "veins," and resembled natural marble.

B. *Combed:* If the colours were manipulated with styluses, combs, or other tools, they formed uniform patterns, swirls, and loops that did not resemble marble.

The following table classifies marbled papers into these two categories, along with historical details and their production techniques. Some papers may combine both techniques.

Detailed Classification of Marbled Papers

The marbled papers are categorized into two main types:

A. Whisked Marbled Papers

1. German - Papier Tourniquet

This pattern consists of small spots likely created by dripping colour onto already coloured paper, forming scattered stains (Fig. 12).

[5] An *Alba Amicorum* is a friendship album (in Greek, *λεύκωμα*), containing handwritten texts from friends and acquaintances. These albums were first used in universities in Germany during the 16th century. Dutch students later adopted this tradition of keeping friendship albums. https://www.kb.nl/en/onderzoeken-vinden/bijzondere-collecties/alba-amicorum#toc-history-of-the-alba-amicorum **[21]**

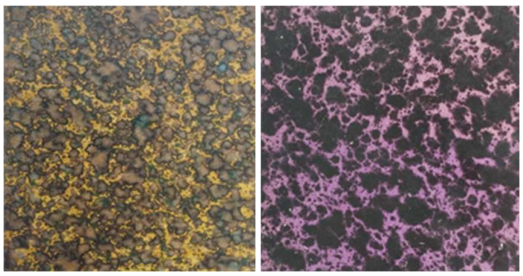

Fig. 12. *German - Papier Tourniquet marbled papers*

2. Twilled Paper - Papier Croisé

Attributed to F. M. Montgolfier in 1830, this pattern belongs to the category of papers called "pseudo-marbled" according to Wolf [26]. Historically, it is referred as Agathe or Achate. It is created by treating paper with potassium hydroxide or caustic potash and then laying it flat. Colours mixed with starch and alum are applied via spraying or sponging. The paper is lifted whereas still wet, allowing colours to flow and create unique patterns (Fig. 13).

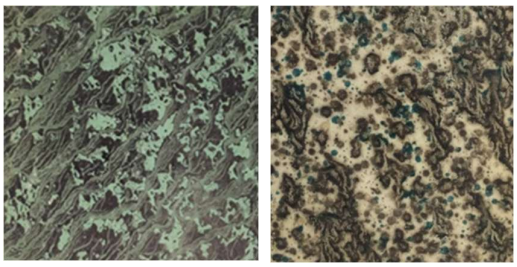

Fig. 13. *Twilled Paper – Papier Croisé marbled papers*

3. Italian - Hair-Vein

This pattern resembles a fine network of veins akin to capillaries. Developed in Italy in the late 18th century, the name either originates from its place of origin or its resemblance to Italian marble. The design is achieved by dispersing colours on a marbling bath surface, then introducing a mixture of soap, ox gall, and alcohol through a fine wire mesh to maintain the size of the dispersed droplets [7] (Fig. 14).

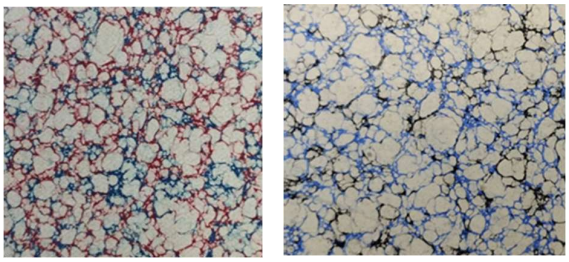

Fig. 14. *Italian - Hair-Vein Twilled marbled papers*

4. Stormont

This paper probably originates from Dublin or France. The use of turpentine as a dispersing agent causes the colours to form tiny dots across the surface, resulting in a lace-like effect [7] (Fig.15).

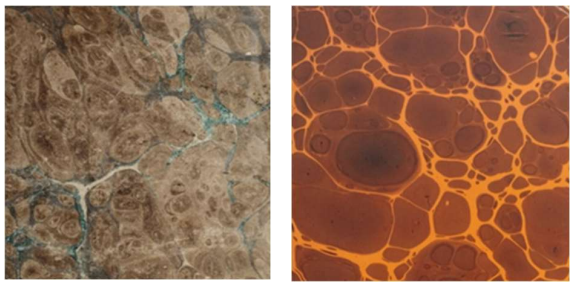

Fig.15. *Stormont marbled papers*

5. Gloster

This pattern features very fine dots and thick, multi-coloured veins. The effect is produced using turpentine mixed with various colours, which are then applied to different areas of the bath. The base layer of colour is also manipulated with a comb or similar tool [7] (Fig. 16).

Fig. 16. *Gloster marbled papers*

6. Shell (French)

Emerging in late 18th-century France, this pattern is made by sprinkling colours onto the bath surface. The final colour, which dominates, is mixed with oil before being dropped into the bath. The oil causes a distinctive white outline to form around each droplet, with a darker centre reminiscent of a seashell [7] (Fig. 17).

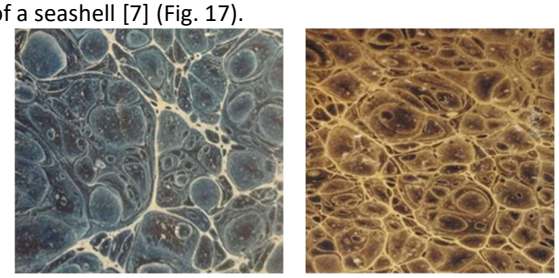

Fig. 17. *Shell (French) marbled papers*

7. Smooth Body

This pattern consists of medium-thickness veins with a solid colour appearance, free of spots or rings [7] (Fig. 18).

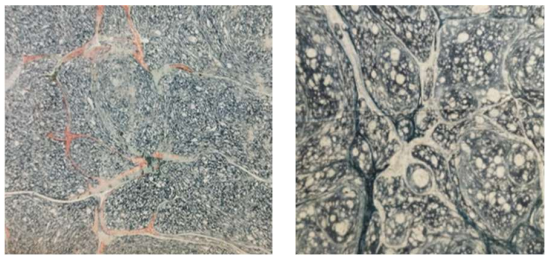

Fig. 18. *Smooth Body marbled papers*

8. Spanish

Developed in the early 17th century, this pattern is known for its diagonal streaks that cross the base design, creating a 'moiré' effect. According to Loring [27], it was discovered accidentally when a marbling apprentice, suffering from a hangover and trembling hands, unintentionally created a linear, graduated pattern whereas placing the paper into the bath. The pattern is typically formed on a Turkish base, with the paper being repeatedly shaken back and forth whereas submerged (Fig. 19).

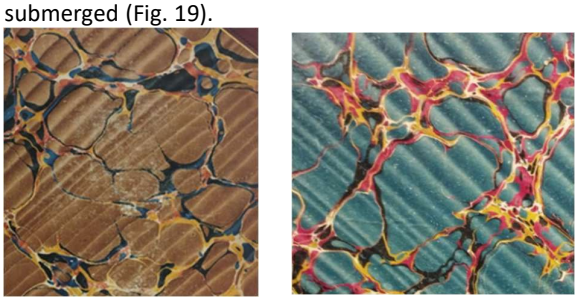

Fig. 19. *Spanish marbled papers*

9. Tiger Sunspot

First appearing around 1855, this pattern is achieved by dropping two or three colours into the bath, followed by a final black layer mixed with limewater and potash solution. The chemical reaction creates spots resembling eyes, with dark irises at the centre out of which tiny rays of the same colour spread all around [27] (Fig. 20).

Fig. 20. *Tiger Sunspot marbled papers*

10. Antique Spot Turkish

This is the oldest of the Western marbled patterns, dating back to the mid-15th century. Initial colours are dropped onto the bath surface, followed by lighter-coloured droplets. The first colours contract, forming vein-like structures around the newer, lighter drops [7] (Fig. 21).

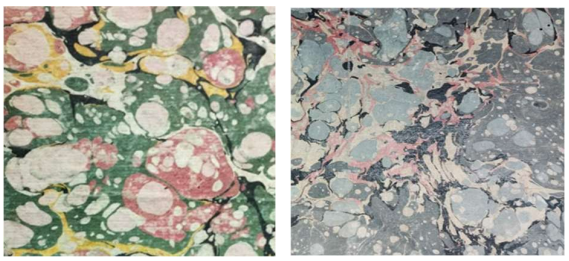

Fig. 21. *Antique Spot / Turkish marbled papers*

11. Morris

Dating to the late 19th century, this pattern was likely created by E. W. Morris, a London printer, or possibly by another Morris working in Oxford. The paper is soaked in water, and colours are poured onto it, dissolving and spreading to create a watercolour effect. This pattern can be achieved using either water-based or oil-based marbling techniques [27] (Fig. 22).

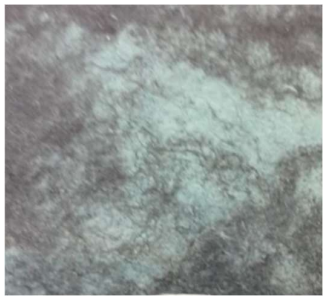

Fig. 22. *Morris marbled paper*

12. Schrottel marbled paper

This pattern was created in Germany in the early 18th century, and its name comes from the German word Schrot which means "small pellet" or "small grain". The design is created by starting with a Turkish base. Then, a mixture of ox gall and oil is poured into the bath. The reaction of this mixture with the existing colours causes the appearance of dark spots with white halos. [27] (Fig. 23).

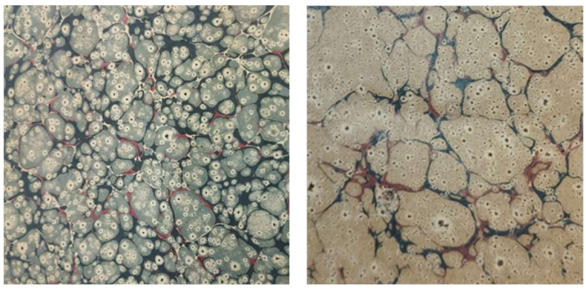

Fig. 23. *Schrottel marbled papers*

B. Combed Marbled Papers

1. Nonpareil

Named after the French word meaning "unparalleled" or "matchless," this pattern features horizontal parallel lines. It is created by sequentially dropping colours into the bath whereas using a tool to evenly distribute the material. A comb with evenly spaced teeth (15-30mm apart) is drawn across the bath in one direction, followed by another pass with a finer comb (apart 0,2cm to 0,3cm) in the opposite direction. This is one of the most widely used marbled paper patterns [7] (Fig. 24).

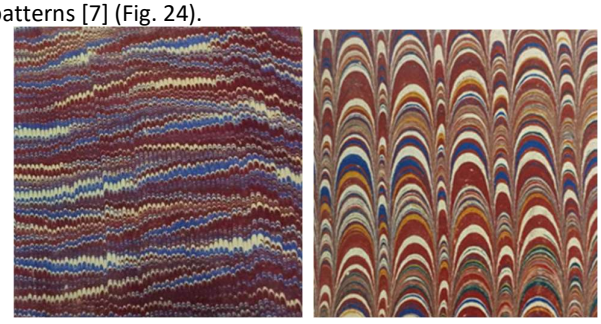

Fig. 24. *Nonpareil marbled papers*

2. Dutch

Similar to Nonpareil, but with precisely ordered colours that occasionally form curls [7] (Fig. 25).

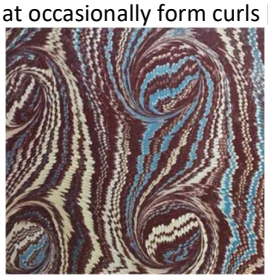

Fig. 25. *Dutch marbled paper*

3. Curl (Snail)

This pattern can be based on any marbled design. Using a special tool resembling a stylus or a comb with wide-spaced teeth, swirling motions are applied to create spiral patterns [7] (Fig. 26).

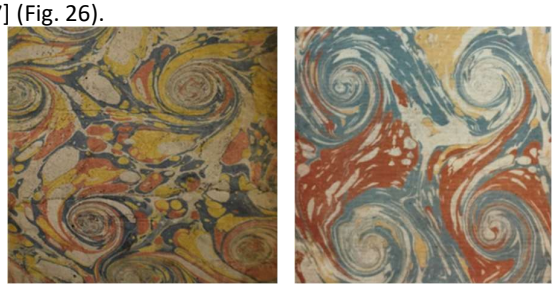

Fig. 26. *Curl (Snail) marbled papers*

4. Peacock

This pattern, along with the next one (Bouquet), requires a tool that creates fan-like or peacock feather-like shapes. After applying a base colour and combing it twice vertically and twice horizontally, a final comb with two rows of teeth is drawn through the bath in a wavy motion, producing feather-like shapes. Peacock closely resembles Bouquet but is always based on the Turkish pattern [27] (Fig. 27).

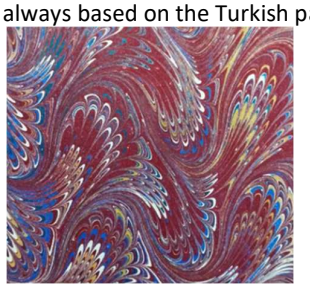

Fig. 27. *Peacock marble paper*

5. Bouquet

Created in the late 18th century, Bouquet is similar to Peacock but starts with a Nonpareil base. A comb with two rows of teeth is dragged through the bath in gentle, wavy motions, causing the Nonpareil columns to form small bouquet-like patterns [27] (Fig. 28).

Fig. 28. *Bouquet marbled papers*

6. Zebra

Popular in the late 19th century, this pattern is often mistaken for Antique Straight. It has a Turkish base with large, scattered colour drops. A comb with a single row of teeth is drawn through the bath vertically twice, followed by additional colour splattering on top [7] (Fig. 29).

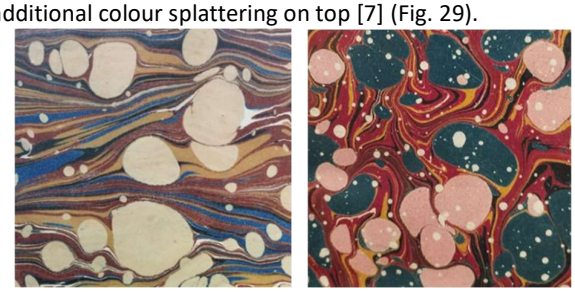

Fig. 29*. Zebra marbled papers*

7. Antique Straight /Antique Zigzag

Like Zebra, it starts with a Turkish base and follows a similar process, but the final colour drops are smaller and more uniform, appearing as tiny dots [7] (Fig. 30 a, b).

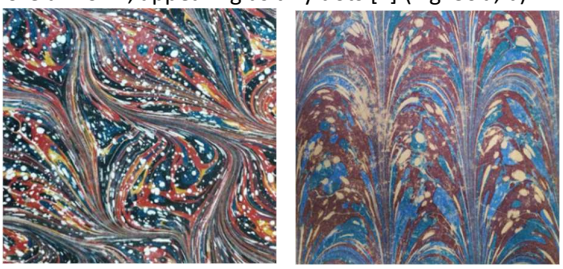

Fig. 30. *a. Antique Zig-zag, b. Antique Straight marbled paper*

Historical Overview

After 1670, marbled paper patterns became widely used, with Old Dutch being the most common design. By the last quarter of the 18th century, Old Dutch was gradually replaced by French Shell, Stormont, and Antique Spot.

In the early 19th century, the Nonpareil and Spanish patterns gained popularity, reviving 17th-century designs.

During the latter half of the 19th century, mid-to-low-cost bookbinding often featured patterns like Gloster, Italian, Antique Spot, with Gold Vein emerging around 1880. German marbled papers with repetitive black spots on coloured backgrounds were also widely used but were not considered artistic.

Leather-bound books of this period often featured a modern version of the Dutch pattern, complementing decorative covers inspired by earlier historical styles. In the last quarter of the 19th century, the Arts and Crafts Movement, led by William Morris, revived traditional marbled paper designs from previous centuries [3]-[8].

C. Surface or Brush Coated Paper

This type of paper has one side prepared with a layer of colour, which is applied evenly with a brush [1].

It was widely used after 1820 in various colours, both matte and glossy. A particularly common colour was yellow in different shades. It was mainly used in cloth (case-bound) bookbinding as well as in artistic bookbinding. However, it was not used as a covering material due to the sensitivity of the colour to mechanical wear [1]-[8] (Fig. 31).

The earliest paper of this type was found on the back of playing cards and in an Alba Amicorum album, which had been coated with red paint using a brush. Based on its watermark, it was dated between 1428-33 [20].

Fig. 31. *Surface or Brush Coated Paper*

D. Coloured Paper

This type of paper acquires its desired colour during its manufacture, through the appropriate colouring of the pulp. In the literature, it is also referred to as Cobb paper, named after the British papermaker Thomas Cobb (17...-18...), who created the first coloured paper (Fig. 32).

In 1796, Thomas Cobb patented a pulp-dying method based on textile dying principles. Cobb's paper was a thin, high-quality, woven paper that was quite durable when wet and came in reddish-brown and olive shades. In the early 19th century, it was used to cover boards, especially in half-calf bindings with sprinkled or gilded top edges[6] [1]-[12]-[29]-[32].

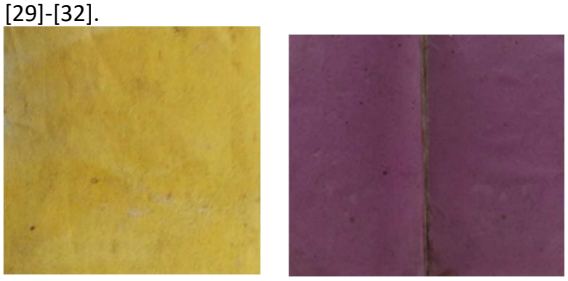

Fig. 32. *Coloured Papers*

The dyes used for colouring were primarily pigments and plant-based dyes. Aniline dyes, well-known in the textile industry, were extensively used after 1856, although their application in the paper industry remained minimal until around 1890 [32].

E. Printed Paper

Printed papers date back to the late 16th century but were used in publisher bindings around 1880.

The term "printed papers" refers to those produced by transferring a hand-carved design from a wooden or metal plate onto paper using the desired colour. Each colour was printed separately, and after drying, the next colour was applied. The designs were created by repeating a small recurring pattern, whereas later, papers featuring floral, foliage, and bird motifs emerged.

Additionally, some papers were printed with gold and copper, although over time, copper oxidized, altering the paper's colour surface. Some of these designs were quite intricate. Printed papers were rarely used in leather bindings but were preferred in cloth bindings [2]-[8].

The production of printed paper required the right tools and skilful engravings by experienced woodcarvers. These papers varied from precise imitations of the texture and patterns of other materials to original, imaginative designs.

Many of these original papers were printed in the 18th century by the Dominotiers of France, who were manufacturers of decorated wallpaper, book covers, playing cards, box linings, and religious images. These early papers were printed on small sheets in a wide variety of patterns, ranging from simple, almost crude woodcuts—either monochrome or in two or more colours—to more complex designs [28][7].

According to Foot [20] the first printed paper dates to 1423. The design was created on a wooden surface, which was then inked with diluted water-based ink or watercolour paint and printed on paper.

In addition to papers printed using wooden blocks (matrices), lithographed papers [8] were also used (Fig. 33).

Fig. 33*. Printed Papers*

F. Sprinkled Paper

Sprinkling has been used in bookbinding for decoration on both leather and book edges since the 16th century. Sprinkled paper is an inexpensive production method where small droplets of colour are spread on the paper's surface by lightly pressing one finger along a brush dipped in paint. This technique was used from the second half of the 16th century) [20].

[6] Endpapers | Rare Books & Manuscripts (adelaide.edu.au)

[7] https://cool.culturalheritage.org/don/dt/dt2684.html

[8] In 1796-98, Alois Senefelder discovered the technique of lithography, in which the lithographer creates the design on a limestone plate using a greasy pencil or chemical ink. The design is then fixed with a solution of gum Arabic and nitric acid, which oxidizes. After about twelve hours, the plate is washed, leaving only the design drawn with the greasy pencil. The plate is then inked, and only the areas with the greasy pencil retain the ink. The design is printed onto paper through the application of pressure. If the printing was in colour, the technique required printing with different plates for each colour. After the introduction of steam presses in 1860, steel plates began to replace limestone plates. From 1900 to 1920, techniques involving colour separation cameras and photographic plates dominated commercial chromolithographic printing. Changes also took place in the materials used, including paper, inks, and varnishes **[29.]**

Sprinkled paper was particularly popular for book covers in Germany, where it is known as *Kiebitzpapier* (literally, "spotted paper"), as the speckled effect was considered like the pattern found on the eggs of certain birds (Fig. 34).

Fig. 34. *Sprinkled Paper*

G. Embossed Paper

Embossed paper was popular in the 18th century and had a textured surface created by a metallic layer of colour (gold, silver, bronze) covering either the entire background of the paper or various decorative patterns. One of the most common patterns was leather simulation. [28][9].

Patterned papers, which feature embossed or printed designs, belong to the same category [28][10].

The process of creating embossed patterns on paper followed these methods:

1. Passing the paper between an engraved or embossed steel roller (or plate) and another roller (or plate) made of soft or easily compressible material, such as paper or cotton.
2. Pressing the paper between hard, coarse fabrics.
3. Passing the paper between two steel rollers with an engraved design, where one roller acts as the male and the other as the female counterpart of the design [25][11].

This category also includes *Dutch gilt papers,* which were produced in the early 18th century in Nuremberg, Augsburg, and Fürth. They became known by this name because the Dutch exported them to the rest of Europe.

Dutch gilt papers were printed from either wooden or metal plates, and the printed designs were usually quite embossed. They are classified into two types:

- Paper initially covered with colour, onto which a gilded design is printed.
- Paper where the design is printed with an inked plate (metal or wood) in various colours immediately after the paper has been gilded. The embossed printing creates an effect similar to that left by decorative tools on leather [3] (Fig. 35, 36).

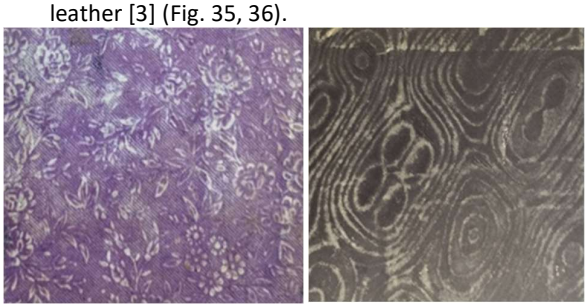

Fig. 35. *Embossed Papers*

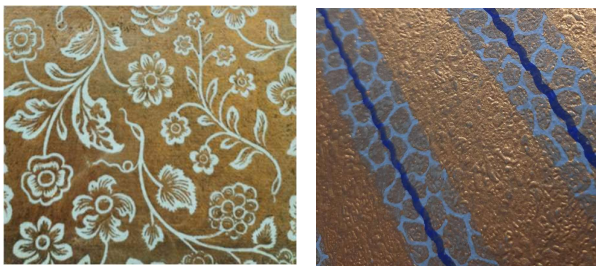

Fig. 36. *Dutch gilt papers*

III. Documentation of Decorated Papers

The term documentation refers to "*an organized system consisting of techniques and technology that supports the organization and transmission of information*" related to a record [17].

The information used for documentation is known as metadata, which is "data about other data; in other words, it is information that is not primary (such as a book, electronic text, or photograph) but rather information that describes a given entity [18],[17], in our case the decorated paper.

Metadata represents a vast body of accumulated, authoritative scientific knowledge that defines the origin and interpretation of each record [16].

Metadata "*serve to describe and organize information, facilitate the identification and management of records, and provide access to them*" [17].

When principles and guidelines, international standards, and a common language define metadata, they ensure the interoperability of a documentation system. These define the processes, the type of information, and the method of recording it so that broad and combined access is possible, as well as the exchange of information between cultural institutions [17]-[18]-[30]-[31].

A. Metadata for the Documentation of Decorated Papers

For the documentation of decorated paper VRA Core 4[12] standard was used as it focuses on the description of works of visual culture as well as the images that document them. In this respect VRA Core was ideal for such description. It soon became evident that there was a need to compliment the VRA elements with specifications regarding type, description and relation. In order to accommodate this DCMI [15] elements were examined. Specifically:

1. TYPE

The type specifies the category and subcategory to which the decorated paper belongs. For example: Marbled paper Nonpareil. If the paper is a lithograph of an original marbling, the title is Lithographed paper Nonpareil.

2. DESCRIPTION

The description includes free text in case additional details need to be recorded that are not included in the predefined elements. For example, an important signature or ex-libris frequently found on the pastedown or the bookbinder's stamp.

3. RELATION

[9] https://cool.culturalheritage.org/don/dt/dt1174.html
[10] https://cool.culturalheritage.org/don/dt/dt2518.html
[11] https://cool.culturalheritage.org/don/dt/dt1174.html
[12] (https://www.loc.gov/standards/vracore/)

Associates the paper with the book in which it is found:
Is Part of: This field specifies the book containing the decorated paper. This way, decorated papers are linked to the book's identification code (Book ID) and all related documentation as we see at Fig.37.
Figure 37 provides a full schema with both the elements of VRA CORE 4 standards [35], and DUBLIN CORE:

- *BOOK (WORK):* Id, Title, Subject, Location, Date, Actor, Inscriptions, Measurements, Material, Condition Statement, Deterioration, Examination, Conservation, Exhibition History, Sources. Rights, BOOKBINDING (Type, Cover, Binder's Blank, Endbands, Sewing, Edges, Spine, Finishing, Endleaves).
- *COLLECTION* (an aggregate of books),
- *IMAGES* (a visual surrogate of books).

4.FORMAT
Medium. Specifies the paper quality, whether it is laid or woven, handmade or industrially produced.
Medium DESCRIPTION colour: Defines the paper's colour
Medium DESCRIPTION pattern: Specifies the decorative pattern.

To define the values that the elements will take for interoperability and ease of search and retrieval, the following standards and controlled vocabularies were used: Art & Architecture Thesaurus (AAT) [33] and Ligatus The Language of bindings [4].

Table II lists the proposed metadata, the mapping with the Dublin Core standard, the vocabulary for each element, and the frequency of use (imperative, optional, repeatable).

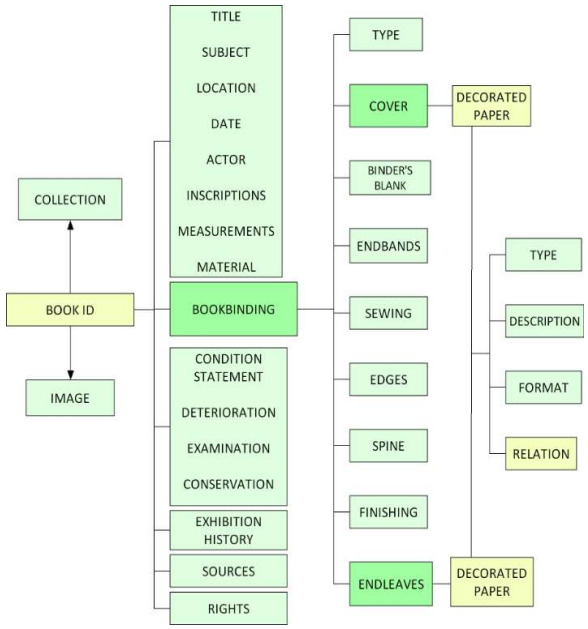

Fig. 37. *Linking metadata for the documentation of decorated papers with metadata of book and bookbinding's documentation.*

IV. CONCLUSION

In this study, a classification of decorated papers was conducted into categories based on bibliographic and field research, to define the metadata for their documentation. With the aim of interoperability, usability, and future expansion of the documentation elements, the VRA Core standard (some of its core elements and their specifications) was selected complimented by DC, as well as controlled vocabularies and standards for thematic processing of the records and encoding of the element values.

This was the basis upon which a database documenting 19th-century bookbinding was built. Same structure and descriptions could be used for paper of other periods, techniques etc. The metadata can be integrated into other databases for more comprehensive documentation of bibliographic materials from other historical periods.

Table II. *Mapping metadata to Dublin Core elements and encoding types*

Metadata description	Terms	Imperative (I) Optional (O) Repeatable (R)
Type Paper Type	Paste paper Pulled paste paper Daubed paste paper Brushed/ spatter paste paper. Drawn/ Combed paste paper Surface Paper Coloured Paper Marbled Paper German Twilled paper Italian (Hair- Vein) Stormont Gloster Shell (French) Smooth Body Spanish Tiger Sunspot Antique Spot- Turkish Morris Schrottel Nonpareil Dutch Curl (Snail) Peacock Bouquet Zebra Antique straight Antique zigzag Printed papers Lithographed paper Block printed paper Sprinkled Paper Embossed Paper Dutch gilt paper	I
Description		O
Format Medium	Paper Wove Laid Handmade Mechanical	I/R
Medium Description: colour	monochrome multicolored pink (colour) red (colour) blue (colour)	I/R

	.....	
Medium Description: Pattern type	moiré diagonal floral patterns grain patterns geometric patterns	I/R
Relation Is part of	Book ID	I

In a library, the organization of a documentation system for decorated papers will contribute to a deeper understanding collection, including cataloguing and preservation.

The availability of the material to user groups will both facilitate access and enhance further study from the perspectives of art history, decoration history, and book history. Furthermore, it will enable the correlation of decorated papers with the bookbinding workshops that used them. Additionally, for more specialized purposes in study and research, the documentation of decorated papers could be expanded with elements relating to the analysis of construction materials (pigments and binding agents) using physicochemical methods, to identify them and, consequently, understand the historical "recipes" used in their production.

Another future attend could be the management of vocabulary, specifically the translation of terms into Greek. At present, the English terminology is adopted, as stated in the Art and Architecture Thesaurus by the GETTY.

V. References

[1] J. Zaehnsdorf, The Art of Bookbinding: A Practical Treatise. London, UK: George Bell and Sons, pp 36-111, 1890. [Online]. Available: https://www.gutenberg.org/files/51213/51213-h/51213-h.htm. [Accessed: Jul. 12, 2024].

[2] T. Tanselle, "The Bibliographical Description of Patterns," Studies in Bibliography, vol. 23, pp 84-85, 1970. [Online]. Available: http://www.jstor.org/stable/40371502. [Accessed: Apr. 15, 2024].

[3] W. Osmun, Decorated Book Papers: Seventeenth to Twentieth Century. New York, NY, USA: The Museum, 1954. [Online]. Available: https://archive.org/details/decoratedbookpap00coop/page/n3/mode/2up. [Accessed: May 14, 2024].

[4] University of the Arts London, "The Language of Bindings Thesaurus," Jun. 21, 2015. [Online]. Available: https://www.ligatus.org.uk/lob/concept/1285. [Accessed: Jul. 4, 2024].

[5] T. Theodorou, The terminology of the History of Bookbinding, In: in Vivlioamfiastis, B. Leggas, Ed. Athens: Hellenic Society of Bookbinding, pp 299-306, 1999.

[6] K. Choulis, Byzantine Bookbinding: History, Art, and Technique, in Vivlioamfiastis, B. Leggas, Ed. Athens: Hellenic Society of Bookbinding, pp 46-49, 1999.

[7] C. Woolnough, The Whole Art of Marbling. London, UK: George Bell and Sons, pp 26-42, 1881. [Online]. Available: https://archive.org/details/wholeartofmarbli00wool/page/n7/mode/2up. [Accessed: Jun. 9, 2024].

[8] B. Middleton, The Restoration of Leather Binding. London, UK: OAK Knoll Press - British Library, pp 33-38, 162, 2004.

[9] A. Ladrick, "The Art of Paper Marbling: An Exploration," Oct. 17, 2023. [Online]. Available: https://storymaps.com/stories/3002b98bf9ce49398046df181888147f [Accessed: May 16, 2024].

[10] Historians of Eighteenth-Century Art & Architecture, "Enfilade Exhibition | Decorated Paper," Dec. 25, 2014. [Online]. Available: https://papelesdecoradosenmadrid.blogspot.com/2014/12/indice.html. [Accessed: Mar. 2, 2024].

[11] A. Celemín, "Traditional Techniques of Paper Decoration and Contemporary Artistic Creation," Dec. 6, 2014. [Online]. Available: https://papelesdecoradosenmadrid.blogspot.com/2014/12/indice.html. [Accessed: Apr. 17, 2024].

[12] L. Hayes, "Rare Books & Manuscripts: Endpapers Cover to Cover: Exposing the Bookbinder's Ancient Craft," May 1, 2018. [Online]. Available: https://www.adelaide.edu.au/library/special/exhibitions/cover-to-cover/endpapers/. [Accessed: May 4, 2024].

[13] Harvard Library, Houghton Library, "Rosamond B. Loring Collection of Decorated Papers," 2020. [Online]. Available: https://hollisarchives.lib.harvard.edu/repositories/24/resources/3070 [Accessed: Mar. 11, 2023].

[14] Wikipedia, "Rosamond B. Loring," Dec. 25, 2014. [Online]. Available: https://en.wikipedia.org/wiki/Rosamond_B._Loring. [Accessed: Apr. 4, 2024].

[15] The Dublin Core™ Metadata Initiative, "Dublin Core," Jul. 25, 2024. [Online]. Available: https://www.dublincore.org/specifications/dublin-core/dces/. [Accessed: Jul. 29, 2024].

[16] S. Kapidakis, F. Lazarinis, and K. Toraki, "Metadata," in Topics in Library Science and Information Science [Undergraduate Textbook]. Kallipos, Open Academic Editions, pp 92-127,2015. [Online]. Available: https://hdl.handle.net/11419/1682. [Accessed: Feb. 3, 2025].

[17] D. Kyriaki-Manessi and A. Koulouris, Digital Content Management [Undergraduate Textbook]. Kallipos, Open Academic Editions, pp 61-76, 2015. [Online]. Available: https://hdl.handle.net/11419/2496. [Accessed: Feb. 3, 2025].

[18] M. Dendrinos and D. Kouis, (2016). Basic Principles and Technologies in Information Science [Undergraduate Textbook]. Kallipos, Open Academic Editions, pp 370-371, 2016. [Online]. Available: https://dx.doi.org/10.57713/kallipos-688. [Accessed: Feb. 3, 2024].

[19] E. Diehl, Bookbinding: Its Background and Technique. New York, NY, USA: Dover Publications, pp 63-186, 1980.

[20] M. M. Foot, "The Olga Hirsch Collection of Decorated Papers," The British Library Journal, vol. 7, no. 1, pp. 12–38, 1981. [Online]. Available: https://www.jstor.org/stable/42554129. [Accessed: Jul. 18, 2024].

[21] National Library of Netherlands, "Alba Amicorum," n.d. [Online]. Available: https://www.kb.nl/en/onderzoeken-vinden/bijzondere-collecties/alba-amicorum#toc-history-of-the-alba-amicorum. [Accessed: Jun. 15, 2024].

[22] En Academic, "Academic Dictionaries and Encyclopaedias," 2013. [Online]. Available: https://greek_greek.en-academic.com/175189/. [Accessed: Jun. 10, 2014].

[23] Wikipedia, "Psyllium", Dec. 25, 2014. [Online]. Available: https://en.wikipedia.org/wiki/Psyllium [Accessed: Apr. 4, 2024].

[24] Wikipedia. "Ox gall"," Dec. 25, 2014 Available: https://en.wikipedia.org/wiki/Ox_gall [Accessed: Apr. 4, 2024].

[25] J. Halfer, The progress of the marbling art, NY: The American Bookbinder Co., 1894. [Online]. Available: https://www.gutenberg.org/files/41241/41241-h/41241-h.htm [Accessed: Jul. 12, 2024].

[26] R. Wolfe, Marbled Paper: Its History, Techniques, and Patterns, With Special Reference to the Relationship of Marbling to Bookbinding in Europe and the Western World. Philadelphia, PA, USA: University of Pennsylvania Press, pp 113, 1990.

[27] University Libraries, University of Washington, "Decorated and Decorative Paper Collection," n.d. [Online]. Available: https://content.lib.washington.edu/dpweb/index.html [Accessed: Apr. 17, 2024].

[28] Conservation OnLine, "Bookbinding and the Conservation of Books: A Dictionary of Descriptive Terminology," n.d. [Online]. Available: https://cool.culturalheritage.org/don/dt/dt1174.html. [Accessed: Jan. 15, 2024].

[29] Mosier, E., Van der Reyden, D., Baker M. (1992). The Technology and Treatment of an Embossed, Chromolithographic "Mechanical" Victorian Valentine Card the Book and Paper Group Annual, The American Institute for Conservation. [Online]. Available: https://cool.culturalheritage.org/coolaic/sg/bpg/annual/v11/bp11-30.html [Accessed: Jul.18, 2024].

[30] P. Konstantopoulos, Guidelines for the Development of Cultural Documentation Systems and the Connection of Digital Cultural Heritage Resources. Cultural Informatics Center, Institute of Informatics, Foundation for Research and Technology – Hellas (FORTH), 2004.

[31] Bekiaris, Ch., (2005), Cultural Metadata (CIDOC CRM & Dublin Core), Presentation at the "Digital Technology Seminar: Libraries, Archives, Museums", Panteion University, June 4-5, 2005, Athens.

[32] J. Irving, "Construction Paper: A Brief History of Impermanence," The Book and Paper Group Annual, vol. 16, The American Institute for Conservation, 1997. [Online]. Available: https://cool.culturalheritage.org/coolaic/sg/bpg/annual/v16/bp16-07.html. [Accessed: Jul. 15, 2024].

[33] The J. Paul Getty Trust. (2021, 25 Ιαν.). Art & Architecture Thesaurus® [Online] Available: https://www.getty.edu/research/tools/vocabularies/aat/ [Accessed: 15 Ιαν. 2023].

[34] M. Guizot, Expedition scientifique de Moree 1831-1835: travaux de la section des sciences physiques. Atlas. Paris: Chez F. G. Levrault, 1835, PL: XI

Library of Congress. May. 4, 2007. *VRA Core 4.0 Element Description* [Online] Available: http://www.loc.gov/standards/vracore/VRA_Core4_Element_Description.pdf [Accessed: Jul. 15, 2024].

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Beyond Metrics: A Framework for Scholarly Evaluation in LIS, Communication, History, and Philosophy

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Abstract:

Purpose *- This research aims to identify, document, and comparatively analyze the reviewer guidelines of the 80 most prominent academic journals, as ranked by Google Scholar Metrics, in the fields of Library and Information Science, Communication, History and Philosophy. The goal is to propose a unified, interoperable, and adaptable conceptual evaluation model that acknowledges disciplinary specificities while preserving scholarly autonomy.*

Design/methodology/approach *- A mixed-methods research design was employed, combining quantitative and qualitative content analysis of 22 sources (16 unique websites, 5 publisher responses, and 1 interview). Structured thematic coding was applied to the material, followed by the creation of four identical text analysis forms, each including eleven pairs of qualitative and quantitative questions aligned with 11 key article evaluation criteria. Descriptive statistics (means, medians, mode values, and standard deviations) were used to rank criteria, while qualitative comparisons were organized into thematic tables with direct excerpts to capture disciplinary similarities and differences.*

Findings *- The study revealed substantial commonalities across fields, particularly the importance of data adequacy, coherence of conclusions, and adherence to ethical standards. Notable disciplinary differences were also identified, such as rhetorical emphasis in Philosophy and technical precision in Library and Information Science. The analysis informed the development of an interoperable conceptual evaluation model structured around shared foundations with adaptable elements tailored to each field.*

Originality/value *- This research contributes an innovative conceptual evaluation framework that combines epistemological inclusivity with cross-disciplinary applicability. By enhancing transparency and supporting reviewers in interdisciplinary contexts, the model offers a foundation for future expansion into additional scientific domains and provides practical guidance for harmonizing article evaluation practices.*

Index Terms — Peer Review Criteria, Scholarly Publishing, Library and Information Science, Communication, History, Philosophy.

I. INTRODUCTION

This research aims to identify, document, and comparatively present the peer review guidelines provided by the most prominent scientific journals in the fields of Library and Information Science (LIS), Communication (Com), History (His) and Philosophy (Phil). Although peer review has long been studied as a mechanism of scientific quality control, previous research has focused mainly on single disciplines or general discussions of review practices [1, 2, 3, 4]. To date, there has been little systematic comparative analysis of how different fields articulate their peer review guidelines, what criteria they emphasize, and how these reflect their underlying epistemological traditions. This absence of comparative knowledge constitutes a critical gap in literature, particularly at a time when interdisciplinary publishing is becoming increasingly common [5, 6, 7, 8].

The goal of this study is to investigate whether there are convergences and divergences in the ways each of these four scientific communities evaluates the individual components of articles submitted for publication within their respective fields. This investigation may reveal previously unexamined aspects of the scientific culture within each domain and enhance interdisciplinary communication by proposing a common, interoperable, and more impartial conceptual evaluation model, where feasible, that simultaneously incorporates the specificities required by each field. In this sense, the study not only identifies disciplinary practices but also seeks to make an original contribution by offering a framework for dialogue across distinct academic traditions.

Accordingly, the research questions addressed in this study were the following:

RQ1 - What are the common methods used by different scientific communities to evaluate the various aspects of articles submitted for publication?

RQ2 - What are the main differences in the evaluation processes across the examined academic disciplines?

RQ3 - What aspects of each field's scientific culture are reflected in the peer review guidelines, and how do these shape the review process?

RQ4 - How can a common, interoperable, and unbiased review model incorporate the particularities and needs of

each scientific field without undermining its autonomy or methodological distinctions?

The selection of the four disciplines for the comparative study of peer review guidelines is justified by the nature of their scientific production. The starting point for this selection is LIS, a field that the authors have systematically researched. It offers a suitable theoretical and methodological basis for understanding the evaluation of scientific sources as a process of quality assurance and credibility within the realm of Scholarly Communication [9], a core concern of LIS. More specifically, LIS explores horizontal practices such as the accumulation, organization, documentation, preservation, retrieval, evaluation, production, and dissemination of information and knowledge, as well as the political and ethical dimensions of scholarly publishing [10]. These features, which also comprise the core competencies proposed by the field of Information Literacy [11], another central topic within LIS, make this domain the most suitable starting point for research that aims to map peer review guidelines across scientific disciplines.

Communication, on the other hand, is considered a distinctly interdisciplinary field, much like LIS. In fact, the relationship between these two fields is becoming increasingly close and complex, especially within the context of a technology-driven society often referred to as the "information age" or the "information society". The growing use of such terms reflects the need for interdisciplinary approaches that bridge information, communication, and human behavior [12. 13, 14]. Modern social sciences now treat these fields less as separate domains and more as interconnected disciplines, adopting integrated theoretical frameworks that examine their interactions across a wide range of levels, from mass communication and interpersonal relations to diplomacy, medical communication, and consumer behavior. Traditionally associated with librarianship and knowledge management, LIS intersects with Communication Studies at the point where the dissemination, access, and interpretation of information involve human interaction and cultural dimensions. Examples such the exchange of doctor-patient information or the use of digital sources by journalists demonstrate how informational and communicational processes are interdependent. At the same time, institutions and cultures are shaped by this interaction, necessitating the development of integrated theoretical and practical tools that serve both domains [15]. Journals in the field of Communication may adopt a variety of approaches, accommodating both quantitative and qualitative research paradigms, while also facing specific challenges in maintaining consistency throughout the peer review process [16, 17, 18, 19]. Therefore, including this field offers the opportunity for a fruitful comparison and may reveal how peer evaluation adapts to a domain that blends theory with practice and increasingly engages in dialogue with LIS.

The inclusion of History and Philosophy allows for the exploration of two representative examples of the Humanities, which are characterized by a strongly qualitative approach to evaluation. In these fields, the assessment of scholarly work is likely based more on theoretical arguments, historical or conceptual interpretations, and a deep understanding of sources or philosophical systems than on measurable data or experimental results. Yet, despite the long-standing traditions of peer review in the Humanities, there is little systematic discussion of how reviewers are instructed to evaluate submissions in History and in Philosophy [20, 21, 3].

Research in the field of History is a fundamental and scientifically structured process that contributes substantially to understanding the past and to the development of theoretical frameworks and practical applications. In contrast to other methods that generate new data, historical research primarily relies on existing sources, employing qualitative and interpretive methodologies. Through the reconstruction of events and the study of human behavior in real-world contexts, the historical method offers not only knowledge but also insight into the processes that shaped institutions, cultures, and practices. Quantified data may be used when appropriate, but it is often difficult to justify quantification beyond tangible evidence, such as statistical data or official records. This research method aims to reconstruct the past by identifying individual elements of a "puzzle" and synthesizing them to offer a deeper understanding of a situation, event, or process [23]. Within the fields of LIS, and of Communication Studies, historical research can be used to explore and understand processes, behaviors, singular events, or usage patterns.

As for Philosophy, research here is mainly based on qualitative, conceptual, and analytical methods, emphasizing critical thinking, systematic reasoning, and the interpretation of theories and texts. Through conceptual analysis, philosophers clarify fundamental concepts and examine the logical coherence of ideas, while also developing and evaluating arguments in areas such as epistemology, ethics, and language. The hermeneutic approach complements the analytical method by focusing on the interpretation of philosophical texts within their historical and intellectual context. Furthermore, reflective methods and thought experiments are employed to explore hypothetical scenarios that shed light on human thought processes and challenge intuitive beliefs. Some contemporary approaches even incorporate qualitative empirical techniques, such as interviews, to explore how people perceive philosophical issues in everyday life [24, 25, 26, 27]. Unlike purely quantitative sciences, philosophy focuses more on understanding than on measurement, adopting paradigms such as interpretivism, constructivism, and phenomenology. Thus, philosophical research substantially contributes to examining the meaning, justification, and consequences of human ideas and beliefs, placing particular emphasis on clarity, coherence, and depth of analysis [28].

Consequently, the guidelines provided by History and Philosophy journals to their reviewers are likely to reflect, with greater clarity, the coexistence of diverse scientific traditions.

This study deliberately excludes, at least at this stage,

domains of the natural sciences, such as mathematics, physics, chemistry, the life sciences, and the medical sciences. The reason for this exclusion lies in the fact that peer review practices and evaluation guidelines in the selected fields of LIS, Communication, History, and Philosophy remain much less systematically explored, as evidenced by the relatively scarce bibliography that follows in the next section. In contrast, natural sciences have been far more extensively studied in this regard, with a substantial body of literature already addressing their evaluation frameworks. Nevertheless, this decision does not preclude the potential future continuation and expansion of the study into these or other academic disciplines, a direction that would not only be of considerable interest but would also further enrich and enhance interdisciplinary dialogue.

II. Related Literature

The literature review conducted in the context of this research aimed to systematically record, study, and evaluate theoretical and empirical approaches to assessing scientific articles, with a focus on the four academic disciplines mentioned above. The search yielded a limited number of relevant articles, highlighting existing gaps in this field. Nevertheless, these articles provided a solid starting point that enabled the identification of key criteria for evaluating scholarly publishing and supported the creative synthesis of findings, formulation of critical commentary, and, ultimately, the drawing of conclusions that contributed to the development of both the theoretical framework and the research tool of this study.

The analysis was based on thematic organization, structured into eleven subsections arranged in a sequence that attempts to reflect both the typical research process and the subsequent writing for publication, each outlining distinct evaluation parameters. The thematic organization was informed by key criteria identified in relevant literature as well as a preliminary study of sources containing peer review guidelines.

The first subsection focused on the “Relevance and Originality of the Research Question”, two axes that play a central role in the initiation of research and in the acceptance of an article. Originality relates to the article’s contribution to new knowledge and the prevention of flawed research dissemination [29]. Bonaccorsi [30] expands on the notion of innovation, emphasizing the importance of a new way of thinking. Other researchers [31, 32] confirm the necessity of originality for editorial approval. Relevance functions as a prerequisite, as the article must respond to the needs of the scientific community to which it is addressed.

The second subsection examines the “Balance and Accuracy of Bibliographic References” situating the study within the existing literature, demonstrating scholarly grounding, and identifying gaps. Literature [33] states that references should meaningfully support the article without being excessive. Bonaccorsi [30] emphasizes the use of primary and foundational sources, while Nicholas & Gordon [34] highlight the completeness and logical structure of the reference list.

The third subsection refers to the “Reliability and Reproducibility of the Methodology” which researchers, authors and publishers jointly work to improve through clear guidelines and assessment systems, although gaps remain. Literature [33] stresses that methods must be described sufficiently to allow replication and emphasizes the need for clear descriptions of statistical and computational methods [29]. Davis et al. [35] highlight the importance of trust in reproducibility, while Brown et al. [36] discuss study design elements. Additional scientific sources point out the challenges and shortcomings in current reproducibility practices [32, 37].

The fourth subsection addresses the “Compliance with Ethical Standards in Research”, which is mandatory before data collection, with explicit declarations in a dedicated section. Relevant sources [29, 33] emphasize the need for approval from ethics committees and transparency. Others [35] refer to open science and data sharing, while avoiding conflicts of interest is deemed essential. Additionally, scientists [37, 38] have highlighted systemic biases and emphasized the need for ethical guidelines from journals.

The fifth subsection examines the “Adequacy of Data to Support Conclusions”. Data must be sufficient, appropriately analyzed with correct statistical methods, and presented with precision including confidence measures when relevant. Conclusions should be limited to what data and study design support, for example, no causal claims unless experimental. Scholars [35] stress the importance of data availability and suitability and warn against overinterpretation [29]. Other sources [32] emphasize the logical continuity between all sections of the article, ensuring that conclusions are directly linked to findings.

The sixth subsection focuses on the “Quality and Clarity of Tables, Charts, and Images” that complement text and improve readability and acceptance chances. Sources [33] emphasize the functional value of visuals in highlighting key findings. Dhillon [29] advocates for a clear layout and adequate information, while Brown et al. [36] focus on accuracy and statistical correctness. Other scientists [31, 34] acknowledge the role of visuals in narrative coherence and argumentative support.

The seventh subsection centers on the “Coherence and Logic of the Argument”. Coherence between findings and reasoning builds epistemic justification, often strengthened by internal mutual support of evidence. Literature [31] highlights the importance of consistency across the article's sections. Moreover, it links argument strength to the soundness of methods [29] and urges reviewers to examine argumentative flow and informational balance [34].

The eighth subsection focuses on the “Consistency of Conclusions with Objectives and Data” which ensures the validity and trustworthiness of the study. Scientists [29, 30] assert that conclusions must be logically followed from the methods and findings. Other sources [31] underscore the chain of consistency linking objectives, methods, and conclusions, noting that avoiding overstatements and omissions is crucial.

The ninth subsection concerns “Effectiveness of the Introduction” in establishing the framework, originality, and

objectives. Researchers [33] note that the introduction should highlight the issue, its significance, gaps in existing knowledge, and the study's aims, without being an exhaustive review of the literature. The quality of bibliographic references is crucial, while the introduction also plays a crucial role in orienting the reader.

The tenth subsection addresses the "Clarity and Readability" of the article, focusing on the effective communication of its content. Sources emphasize the need for message clarity [33] and call for focus on language and precision [29]. Additionally, they emphasize the importance of readability for content reception [35] and relate it to the article's production stage [38].

The eleventh and final subsection concerns the "Optimization of Title, Abstract, and Keywords for Search Engines". Literature [33, 36] stresses the importance of these elements for the article's visibility and emphasize their role in strategic indexing and accessibility [32, 38].

A potential twelfth criterion for evaluating the quality of scholarly publishing could be the integration of Artificial Intelligence (AI). However, as this remains an emerging theme with insufficient and fragmented bibliography on these specific aspects, it warrants separate investigation in future research. Such a study could map the previously mentioned eleven criteria in relation to AI use. While no articles were found that directly address AI in these evaluative dimensions, its application in research methodology, analysis, and writing is rapidly expanding. Importantly, the ethical use of AI requires transparency and validation, paralleling the principles of reproducibility and adherence to ethical standards.

In conclusion, the literature review highlighted several theoretical and empirical parameters that form the foundation for evaluating the quality of scientific articles. The documented analysis of these eleven parameters significantly contributed to shaping the research process followed in conducting this study.

III. Methodology

A. Underneath Concept for the Choice of Method

This study employed a mixed-methods research approach. "Mixed-methods research is formally defined as the class of research where the researcher combines or mixes quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" [39]. This approach integrates elements of qualitative analysis, such as hermeneutic interpretation, thematic categorization, and conceptual content understanding, with more systematic, and sometimes quantifiable techniques associated with structured study designs. The term "mixed-methods" reflects precisely this hybrid, an analysis that is neither strictly qualitative nor fully quantitative. This methodological approach offers scientific validity, reproducibility, and interpretive depth [40, 41]. Mixed-methods are considered the "third" research paradigm, encompassing both positivist-inspired quantitative approaches and qualitative methods rooted in interpretivism, critical theory, and post-structuralism.

However, its underlying philosophical stance is pragmatism, enabling researchers to draw on the strengths of both traditions. Researchers collect, analyze, and integrate both types of data, combining statistical generalizability with deep contextual insight [42].

In this study, a mixed-methods approach was employed to analyze specific content related to peer review evaluation criteria for academic publications. The aim was to gain an interpretive understanding of how articles are assessed across four scientific domains, while systematically recording and measuring the frequency of particular evaluation dimensions. This dual process enabled the quantification of themes without losing semantic richness. Ultimately, this approach supported both interpretive analysis and a ranked categorization of themes, resulting in the proposition of a unified, interoperable, and reproducible conceptual evaluation model applicable across four academic disciplines.

B. Presentation of Research Sample

Initially, it was estimated that by selecting the 80 most popular journals, based on the Google Scholar Metrics tool, in the fields of LIS, Communication, History, and Philosophy, 20 journals per field, it would be possible to identify 80 different sources containing peer review guidelines for submitted articles. Thus, the research sample would be sufficiently rich in information, enabling the identification of the most important evaluation criteria for publications in these fields, while also being highly reliable, given that these were the most prestigious journals. This could lead to results and conclusions that are both reliable and in-depth, supporting the proposal of a unified, interoperable conceptual evaluation model for research in the aforementioned fields, while simultaneously incorporating the particularities of each field.

During data collection, it was observed that not all journals in the sample provided guidelines for peer review. Of the 80 journals examined (see Annex Fig. 5, Fig. 6, Fig. 7, and Fig. 8), 76 had a dedicated webpage containing such instructions, while no relevant content could be located for the remaining 4. Furthermore, when processing the identified URLs, for each of the 76 journals, it became evident that many of them referred to identical content because their reviewer guidelines were hosted on shared webpages maintained by publishing houses. This occurs when multiple journals belonging to the same publisher rely on a single, unified reviewer guidelines page, regardless of the journal's title or scientific field.

In total, from the comparison and grouping of all 76 URLs, 16 unique yet comprehensive webpages were identified, which included the review guidelines for nearly all selected journals. The content of these webpages served as the primary source for the thematic analysis, the extraction of qualitative categories, and the measurement of quantitative data within the context of this study.

To identify additional and potentially more specialized reviewer instructions, email communication requests were sent to the editors and publishers of the journals, asking them to provide internal documents or non-public

guidelines. Specifically, 80 emails were sent to all 80 journal editors. Of these, only 5 responded by providing the requested guidelines. This limited response made only a slight contribution to enriching the information analyzed in the study.

It is worth noting that one of the editors expressed willingness to provide additional clarification of the materials through an online interview. The interview significantly contributed to a deeper understanding of the concepts discussed in the findings of this paper.

The total number of documents studied amounted to 21 (16 webpages + 5 emails). Adding the interview transcript, the final sample consists of 22 review guideline texts, covering the 80 most popular journals, according to Google Scholar Metrics, in the fields of LIS, Communication, History, and Philosophy.

More specifically, the 22 sources include:

Source 1 – A webpage with review guidelines by Taylor and Francis publishers, referenced by 14 out of the 80 selected journals: 7/20 in Communication, 5/20 in History, and 2/20 in Philosophy.

Source 2 – A webpage with review guidelines by Sage Publishing, referenced by 12/80 journals: 8/20 in Communication, 3/20 in Library and Information Science, and 1/20 in History.

Source 3 – A webpage with review guidelines by Springer, referenced by 10/80 journals: 9/20 in Philosophy and 1/20 in LIS.

Source 4 – A webpage with review guidelines by Wiley, referenced by 10/80 journals: 5/20 in Philosophy, 3/20 in LIS, and 2/20 in History.

Source 5 – A webpage with review guidelines by Cambridge University Press, referenced by 10/80 journals: 9/20 in History and 1/20 in Philosophy.

Source 6 – A webpage with review guidelines by Emerald Publishing, referenced by 6/80 journals: all 6 from the 20 LIS journals.

Source 7 – A webpage with review guidelines by Elsevier, referenced by 5/80 journals: 3/20 in LIS and 2/20 in Communication.

Sources 8–12 – Five separate webpages with review guidelines by Oxford Academic. Sources 8, 9, and 10 concern 3/20 History journals; source 11 concerns 1/20 Philosophy journals; and source 12 concerns 1/20 Communication journals.

Source 13 – A webpage with review guidelines by MIT Press Direct for 1/20 LIS journals.

Source 14 – A webpage with review guidelines by the Medical Library Association (MLA) for 1/20 LIS journals.

Source 15 – A webpage with review guidelines by College & Research Libraries for 1/20 Information Science journals.

Source 16 – A webpage with review guidelines by Cogitatio Press for 1/20 Communication journals.

Source 17 – An email with peer-review instructions from the editors of the journal "International Journal of Communication", 1/20 Communication journals.

Additional Sources 18–20 – Emails with peer review guidelines from the editors of the journals "The History of the Family", "Law and History Review", and an interview with the editor of "Enterprise & Society", 3/20 History journals.

Additional Source 21 – An email with peer review guidelines from the editor of the "Philosophy journal Mind & Language".

Additional Source 22 – An email with peer review guidelines from the editor of the "Library and Information Science Journal Learned Publishing".

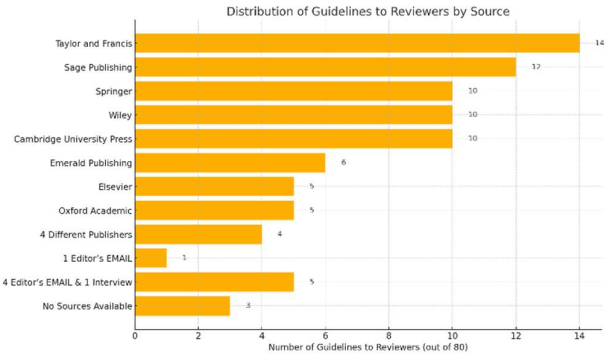

Fig. 1*. Distribution of Guidelines by Source.*

It is worth noting that the distribution of reviewer guidelines across scientific fields reveals variations in both the number of accessible sources and their origin, which influence the interpretation of the findings and the drawing of comparable conclusions across domains. Specifically, LIS and Communication demonstrated a diversity of publishing sources with a wide range of origins (e.g., Sage, Elsevier, Emerald, MIT Press, MLA, College & Research Libraries), which enhances the thematic and qualitative differentiation of their material. In particular, the 20 journals in LIS are linked to at least 8 different sources of reviewer guidelines, while those in Communication are linked to 6.

In contrast, Philosophy and History show a higher degree of concentration of guidelines within specific publishing houses, mainly Springer, Wiley, Cambridge University Press, and Oxford Academic, thereby limiting the diversity of evaluation criteria identified. For instance, the 20 Philosophy journals primarily refer to Source 3 (Springer) and Source 4 (Wiley), while a significant number of History journals are associated with Source 1 (Taylor & Francis) and Source 5 (Cambridge). This relative homogeneity may reflect either institutionally established practices or a lack of thematic specialization which affects the research's ability to highlight disciplinary particularities with equal clarity across all fields.

Overall, the uneven distribution and differentiation of sources per field imposes limitations on balanced comparative analysis, making it necessary to adopt a careful interpretation of findings, especially when drawing general conclusions or proposing unified evaluation models.

C. Research Procedure Followed

For the implementation of this research, the following process was adopted.

Stage 1: Data Collection

The data collection was based on the content of the peer review guidelines of the 80 top-ranked scholarly journals in

the fields of Library and Information Science (LIS), Communication (Com), History (His), and Philology (Phil), as listed in Google Scholar Metrics. During research, a total of 22 distinct sources of reference were identified, which were not evenly distributed across the journals. For instance, Source 1 was found in 14 journals, Source 2 in 12 journals, and so forth (see B. Presentation of Research Sample). For reasons of conceptual consistency, the term "source" is hereafter used to denote each of the 80 journals in which peer review guideline content was identified.

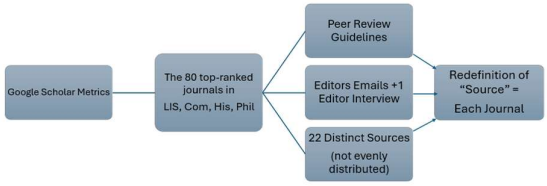

Fig. 2. *Stage 1: Data Collection.*

Stage 2: Identification of Semantic Units

During the examination of each source, specific semantic units were identified, such as "data adequacy", "data quality", "relationship between data and conclusions", etc. More specifically, semantic units are keywords or phrases that refer to a common topic and can be grouped into a unified conceptual set.

This process of qualitative text analysis was conducted through the lens of deductive reasoning. Having previously reviewed the relevant literature and preliminarily skimming the sources containing peer review guidelines, the researchers had identified broad categories of criteria that peer reviewers are expected to examine. The analysis therefore focused on locating keywords and phrases corresponding to these predetermined categories, while also allowing for the inclusion of any additional units and categories that emerged.

Whenever a word or phrase aligned with the predetermined categories or with categories that emerged during the analysis, it was recorded as a "semantic unit".

Each semantic unit was then recorded as a narrower term and classified under a corresponding broader conceptual category. For example, the aforementioned semantic units were grouped into the category "Adequacy of the Data to Support the Conclusions".

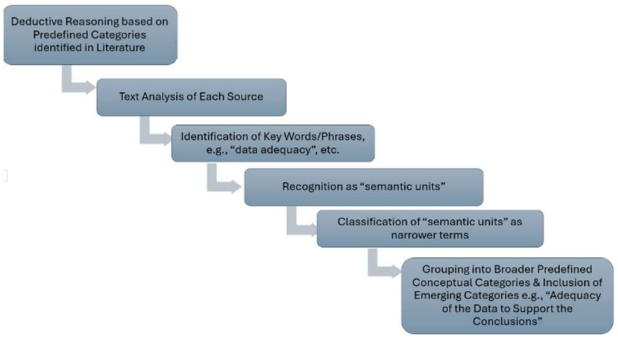

Fig. 3*. Stage 2: Identification of Semantic Units.*

Stage 3: Coding and Interpretation of Conceptual Categories

Text analysis yielded eleven (11) broad conceptual categories. The fact that these categories referred to a common theme not only revealed convergences but also surfaced differences in how each source treated the same theme. Thus, every category was coded with an indicator of similarity in all four scientific domains or differences, e.g., "differences for LIS". Furthermore, it was compared with the relevant literature in order to further clarify its meaning. Through this process, conclusions were drawn regarding its potential contribution to the development of a conceptual peer review model across four domains.

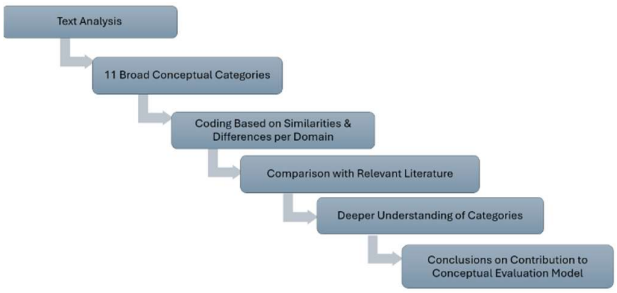

Fig. 4*. Stage 3: Coding and Interpretation of Conceptual Categories.*

Stage 4: Development of a Conceptual Evaluation Model

Each category is presented as a Criterion of Publication Evaluation (CPE), functioning as a broader term. (See Results and Discussion: Proposed Modeling Framework for Each Criterion).

Every CPE is structured around three conceptual pillars:

Evaluated Dimensions and Subdimensions, where applicable – the specific aspects that are assessed under the given criterion.

Description – namely, a coded definition with systematic description/interpretation of each dimension.

Common & Specific Points – namely, the scope of application, whether each dimension applies across all four fields (LIS, Com, His, Phil) or only to one/some of them.

Stage 5: Quantitative Measurement and Ranking

Simultaneously, a frequency count was conducted for the appearance of each word or phrase that was coded as a "semantic unit", separately for each of the 20 journals per scientific field, a total of 80 journals (Sources). This word or phrase, when found verbatim e.g., "data adequacy", and directly referring to a broader conceptual category, was entered into a data form once for each journal's source that included it. For example, Source 1 was examined 14 times, and the result was entered 14 times, corresponding to the number of journals referencing that same source.

The "semantic unit" was then assigned a value using the following 7-point importance scale, using inter-coding for reliability:

1 – Not important at all

2 – Very low importance
3 – Low importance
4 – Moderate importance
5 – Important
6 – Very important
7 – Extremely important

Example of Quantitative Measurement and Ranking

The criterion "Adequacy of the Data to Support the Conclusions" was evaluated as follows:

For the 20 journals in the field of LIS, the frequency of occurrence of the semantic units associated with this criterion was high. Of the 20 values the following were calculated:

x̄ (Mean): The total average of all 20 values of LIS journals was calculated to reflect the overall trend and indicate how highly or poorly the criterion was rated. A higher mean denotes a stronger preference: 6,15

Mo (Mode): The total mode of all 20 values of LIS journals was calculated to indicate the most frequently occurring value, reflecting the most typical score assigned by the researchers: 7

Med (Median): The total median of all 20 values of LIS journals was calculated to represent the central value of the ordered dataset, useful in the presence of outliers: 7

Σ (x̄ + Med + Mo): Sum of the mean, median, and mode: **20,15**

σ (Standard Deviation): The total standard deviation of all 20 values of LIS journals was calculated to reflect the level of agreement among evaluators. A low σ indicates consistency, while a high σ reflects divergence in views: 1,18

Final Value of CPE 1 in LIS →Σ (x̄ + Med + Mo) – σ: (20,15)- 1,18 = 18,97

It should be noted that subtracting the standard deviation from the sum of the mean, median, and mode serves as a way to account for and neutralize the dispersion of the values.

This value of **18,97** was subsequently rescaled to a 7-point scale, yielding a final score of **6,63**.

The same procedure was applied to the remaining three fields (Com, His, Phil) to obtain comparable results.

Lastly, the same procedure was re-applied to all 80 journals (LIS, Com, His, Phil) (see Table 1.).

The outcome of this process was both a horizontal ranking of each evaluation criterion by importance, and a vertical mapping per scientific domain. This dual visualization enhances understanding of the significance of each criterion by utilizing reliable, quantifiable, and reproducible data.

This quantification process complemented the qualitative text analysis allowing the researchers to apply a mixed-methods research approach.

IV. Results and Discussion

What follows is the presentation of the main quantitative and qualitative findings of the study, organized by the most to the least important Criterion of Publication Evaluation (CPE) across the four scientific domains (LIS, Com, His, Phil). This is accompanied by a discussion, supported by the relevant literature.

Table 1. *C1 - Adequacy of the Data to Support the Conclusions*

CPE	**C1 - Adequacy of the Data to Support the Conclusions**				
Science	**LIS**	**His**	**Phil**	**Com**	**Total**
x̄	6,15	6,25	6,1	5,65	**6,03**
Med	7	7	7	6	**6**
Mo	7	7	7	6	**7**
Σ (x̄ + Med + Mo)	**20,15**	**20,25**	**20,1**	**17,65**	**19,03**
σ	1,18	1,45	1,62	0,93	**1,30**
Final Value = Σ (x̄ + Med + Mo) – σ	**18,97**	**18,8**	**18,48**	**16,72**	**17,72**
Mapping to a 7-Point Importance Scale	**6,63**	**6,58**	**6,46**	**5,85**	**6,20**

All academic fields show a positive evaluation regarding C1 – Adequacy of the Data to Support the Conclusions, with average scores (x̄) above 5,65. Library and Information Science and History stand out, giving the highest final values and perceived importance on the 7-point scale. Communication has the lowest scores but still falls within a positive range. The degree of agreement among reviewers varies, with Philosophy showing the greatest divergence (σ = 1,62). Overall, C1 is considered the most important among 11 criteria, supported by statistical indicators that confirm its strong position in the evaluation process.

Table 2. *Proposed Modeling Framework for the 1st Criterion*

Proposed Modeling Framework for the 1st Criterion: Adequacy of the Data to Support the Conclusions		
Evaluated Dimension	**Description**	**Common & Specific Points**
Data Completeness	The data is sufficient in quantity, scope, and depth to support the conclusions	Common across all fields
Quality and Validity	The data is accurate, authentic, and free from contradictions or ambiguities	Common across all fields, with particular emphasis in His and Phil on coherence and documentation
Logical Connection to Conclusions	There is a clear alignment between the data and the conclusions	Common across all fields, but Phil and LIS specifically emphasize avoiding overinterpretation
Documentation and Transparency	The process of data collection, analysis, and presentation is clear and verifiable	Emphasis is placed on LIS and Com
Reproducibility	Sufficient information is provided for the analysis to be replicated by other researchers	Strong emphasis in Com and LIS
Statistical Justification	Statistical tools are used where appropriate, with correct presentation and documentation	Special emphasis in Com and LIS
Addressing Methodological Limitations	Alternative interpretations or limitations in data interpretation are acknowledged	Special emphasis in Phil and LIS
Theoretical Integration (where applicable)	The data are conceptually or theoretically situated within existing research or theoretical frameworks	Specific point for LIS
Identification of Insufficient or Contradictory Data	Reviewers are asked to identify cases where the data does not support the conclusions or suggest alternative interpretations	Common across all fields, but with increased explicit presence in His and Phil
Ethical Use and Authenticity	It is confirmed that the data have been collected and used ethically and legally (e.g., no fabricated data)	Special emphasis in the field of Com

The analysis of C1 – Adequacy of the Data to Support the Conclusions highlights the importance of transparency, validity, and logical coherence between the data and the

conclusions. All academic fields agree on the need for reliable data, which supports the development of a shared core evaluation framework. At the same time, distinct priorities emerge across disciplines, for example, ethical concerns in Communication and theoretical integration in LIS, pointing to the need for flexible, adaptive evaluation tools that reflect the specific nature of each field. Davis et al. [35] emphasize not just the presence of data, but their usefulness and accessibility. The fact that reviewers are expected to assess whether the data genuinely support the conclusions, rather than merely accompany them, reveals a need for quality control in the logical flow of the paper, an aspect also stressed by Haines et al. [31]. Dhillon [29], on the other hand, proposes sharper reviewer questions, such as whether alternative interpretations are ignored or conclusions overstated, offering a more robust conceptual evaluation tool that is often lacking in descriptive models. This analysis affirms the necessity of incorporating such parameters, namely, that the link between data and interpretation must be explicit and clear. Warnings against overinterpretation or unjustified generalizations, raised by many scholars [29, 35], align well with findings across disciplines. Therefore, C1 is a criterion that, while conceptually unified, takes on different forms depending on the field. For modeling purposes, the challenge lies in maintaining a strong evaluative foundation, focused on persuasiveness, transparency, and alignment between data and claims, while allowing interpretive flexibility tailored to each discipline's epistemological traits.

Table 3. *C2 – Consistency of Conclusions with Research Goals and Data*

CPE	**C2 – Consistency of Conclusions with Research Goals and Data**				
Science	**Phil**	**LIS**	**His**	**Com**	**Total**
x̄	6,1	6,1	6	5,2	**5,85**
Med	7	6,5	7	5	**6**
Mo	7	7	7	5	**7**
Σ (x̄ + Med + Mo)	**20,1**	**19,6**	**20**	**15,2**	**18,85**
σ	1,62	1,17	1,62	1,11	**1,41**
Final Value = Σ (x̄ + Med + Mo) – σ	**18,48**	**18,43**	**18,38**	**14,09**	**17,43**
Mapping to a 7-Point Importance Scale	**6,46**	**6,45**	**6,43**	**4,93**	**6,10**

The analysis of C2 – Consistency of Conclusions with Research Goals and Data shows strong acceptance across most fields, with Philosophy and LIS recording the highest scores, followed by History. Communication ranks lower, with more cautious evaluations and reduced scores. Despite showing the smallest variation (σ=1,11), indicating higher agreement among reviewers, its final score places it in the "moderate to important" category. Overall, the average score across all fields (6,10) reflects a strong recognition of the criterion's importance.

Table 4. *Proposed Modeling Framework for the 2nd Criterion*

Proposed Modeling Framework for the 2nd Criterion: Consistency of Conclusions with Research Goals and Data		
Evaluated Dimension	**Description**	**Common & Specific Points**
Alignment of Conclusions with Goals	Assesses the extent to which the conclusions directly address the research questions or objectives of the study	An explicit connection to research questions often appears in qualitative articles. In fields like Phil or His, alignment is based more on logical and thematic coherence rather than on explicitly stated functional questions
Support for Conclusions by Data	Assesses the extent to which the conclusions are adequately substantiated by the results and empirical findings	Frequent use of quotes or examples is observed in qualitative studies (e.g., Com). There is a need to avoid generalizations that are not justified by the sample size or type
Logical Flow and Coherence	Examines the smooth and logical transition from data to interpretation and final conclusions	Narrative coherence is especially critical in theoretical fields such as His and Phil. In empirical articles, the explicit structure (methods → results → discussion) tends to be more standardized
Addressing Alternative Interpretations	Assesses whether the article acknowledges and discusses possible objections or alternative approaches	Mention of limitations is more systematic in quantitative fields. Theoretical evaluation of alternative viewpoints appears primarily in Phil articles
Consistency with Methodology	Conclusions are evaluated based on whether they align with the limitations and capacities of the methodology used	A common issue is the overinterpretation of results from small samples or case studies. Balance is needed between theoretical generalizations and the methodological framework

The analysis of C2 – Consistency of Conclusions with Research Goals and Data highlights its horizontal significance across academic fields, while also revealing nuanced differences shaped by the nature of each discipline. Integrating this criterion into an evaluation model for scholarly publications strengthens scientific validity and helps prevent critical reasoning flaws. First, C2 acts as a bridge between all research stages, from the formulation of aims to methodology and data analysis. A clear mechanism to assess alignment ensures systematic and evidence-based quality evaluation. Second, modeling this criterion enhances the reliability of assessments by reducing the likelihood of endorsing studies based on arbitrary or weak analyses. As emphasized by researchers [29, 33], conclusions must logically follow from goals and data, making this criterion essential for scientific coherence and transparency. Third, incorporating C2 into evaluation tools offers guidance to authors, encouraging well-structured conclusions and avoiding overinterpretation, as underscored by Haines et al. [31]. Challenges include subjectivity in defining coherence, particularly in theoretical fields such as Philosophy, and the diversity of article types within disciplines. For example, in Communication, coherence often relates to narrative structure, while in LIS, it leans on statistical validity.

Moreover, there's a lack of concrete tools to support reviewers in evaluating consistency. Although the literature suggests conceptual approaches such as Aggarwal's "consistency chain" [33], standardized implementation is rare. Comparative literature reinforces the criterion's importance. Researchers [31, 33] view consistency as central to writing decisions, and stress the importance of limiting conclusions to what the data justify [29]. Nicholas and Gordon [34] emphasize narrative unit, a core aspect of C2. Ultimately, consistency between conclusions, goals, and data is critical for scientific rigor and offers strong potential as a structural criterion in evaluation models. To fully harness its value, it must be supported by clear, field-specific indicators that promote objectivity and practical use.

Table 5. *C3 - Clarity and Readability of the Evaluated Article*

CPE	**C3 - Clarity and Readability of the Evaluated Article**				
Science	**LIS**	**Phil**	**His**	**Com**	**Total**
x̄	4,9	4,9	4,9	4,7	**4,85**
Med	5	5	5	4	**5**
Mo	6	5	5	4	**6**
Σ (x̄ + Med + Mo)	**15,9**	**14,9**	**14,9**	**12,7**	**15,85**
σ	1,12	1,07	1,45	1,13	**1,17**
Final Value = Σ (x̄ + Med + Mo) – σ	**14,78**	**13,83**	**13,5**	**11,57**	**14,67**
Mapping to a 7-Point Importance Scale	**5,17**	**4,84**	**4,73**	**4,04**	**5,13**

C3 – Clarity and Readability of the Evaluated Article is overall assessed as having moderate to significant importance. LIS records the highest final score (5,17), while Communication ranks lowest (4,05), indicating that it places comparatively less emphasis on this criterion. Philosophy shows the highest agreement among reviewers, in contrast to History, which displays the most significant variability (σ=1,45). The most frequent score in LIS (6) reflects a higher perceived importance by many reviewers. These findings highlight the need for field-specific clarity standards tailored to the character and style of each academic discipline.

The benefits and limitations of modeling C3 – Clarity and Readability of the Evaluated Article can be summarized as follows: Among the benefits, the presence of shared features across disciplines provides a strong foundation for creating a unified evaluation framework focused on language clarity, structural organization, readability, and adherence to journal guidelines. Differences between fields also allow for specialization, making the model both adaptable and dynamic. For example, the suggestion from LIS to evaluate specific sections of an article in greater detail could be extended across disciplines to support more granular assessments. However, some limitations remain. Fields such as History and Philosophy often lack explicitly defined technical criteria, which can complicate standardization. Additionally, varying tolerance for language errors can lead to inconsistencies in how the criterion is applied, especially in international contexts where linguistic precision strongly affects readability. Findings from this study align closely with literature.

Table 6. *Proposed Modeling Framework for the 3rd Criterion*

Proposed Modeling Framework for the 3rd Criterion: Clarity and Readability of the Evaluated Article			
Evaluated Dimension	**Sub-dimension**	**Description**	**Common & Specific Points**
1. Language Clarity	1.1 Linguistic Precision & Clarity	The language is clear, free from ambiguities, and avoids specialized terminology without explanation	Common across all fields
	1.2 Grammatical Accuracy	Assesses the impact of language errors on the reader's understanding of the text	Common across all fields with slightly greater tolerance in LIS and Com
	1.3 Tone & Style	Appropriate academic language, neither overly informal nor unnecessarily complex	Common across all fields
2. Structure & Organization	2.1 Logical Arrangement of Sections	Adherence to basic academic structure (introduction, method, results, conclusions where applicable)	Common across all fields
	2.2 Structural Elements (Headings, Paragraphs)	Use of clear, functional sub-sections and transitions to ensure coherence	Common across all fields
	2.3 Argument Coherence	The argument is developed logically and progresses in a clear, structured manner.	Especially in Phil and His
3. Readability	3.1 Suitability for the Journal's Audience	The article aligns with the knowledge level and disciplinary focus of the journal's readership	Especially in LIS and Com
	3.2 Use of Visuals (Graphs, Tables, Figures)	Visual elements enhance comprehension and are appropriately placed and well-documented	Common across all fields –more pronounced in LIS
	3.3 Compliance with Journal Guidelines	The article adheres to formatting, word count, language, and presentation requirements specified by the journal	Common across all fields
4. Guided Evaluation	4.1 Comments & Suggestions for Improvement	Reviewers offer constructive feedback to enhance the clarity and communicative effectiveness of the article (Aggarwal et al., 2022).	Common across all fields

Clarity as a pillar of scientific value is recognized across all fields [29]. Readability as a factor of accessibility is particularly emphasized in Communication and Library and Information Science, especially regarding tables, visuals, and technical phrasing [35]. The advisory role of reviewers in improving article quality is reflected in their comments and suggestions [33], while compliance with journal standards is a common requirement and useful modeling tool [38]. Clarity and readability are not peripheral, but core indicators of an article's quality, impact, and scientific influence.

Table 7. *C4 - Balance and Accuracy of Bibliographic References*

CPE	**C4 - Balance and Accuracy of Bibliographic References**				
Science	**Phil**	**His**	**LIS**	**Com**	**Total**
x̄	5,85	5,45	4,5	3,8	**4,9**
Med	7	6,5	4	4	**4,5**
Mo	7	7	3	3	**7**
Σ (x̄ + Med + Mo)	**19,85**	**18,95**	**11,5**	**10,8**	**16,4**
σ	1,81	1,99	1,57	1,01	**1,78**
Final Value = Σ (x̄ + Med + Mo) – σ	**18,04**	**16,9**	**9,93**	**9,79**	**14,61**
Mapping to a 7-Point Importance Scale	**6,31**	**5,93**	**3,47**	**3,42**	**5,11**

Philosophy records the highest average score (5,85) and final value (6,31), followed by History (avg. 5,45, final 5,94), indicating that the Humanities place strong emphasis on balanced and high-quality use of references. In contrast, Communication (avg. 3,8, final 3,42) and LIS (avg. 4,5, final 3,47) assign less importance to this criterion. Median and most frequent values in the Humanities (up to 7) further confirm this trend, while the low variability in Communication (σ= 1,01) suggests reviewer agreement, despite the lower scores. Overall, solid bibliographic support is a key quality indicator in Philosophy and History, unlike the weaker referencing practices and possible lower theoretical emphasis observed in Communication and LIS. The need to improve referencing standards in these latter fields is clear, particularly in the context of developing a unified evaluation framework.

Table 8. *Proposed Modeling Framework for the 4th Criterion*

Proposed Modeling Framework for the 4th Criterion: Balance and Accuracy of Bibliographic References		
Evaluated Dimension	**Description**	**Common & Specific Points**
Topical and Temporal Relevance	References are meaningfully related to the research subject and include recent and/or foundational works	All fields agree on the importance of citations being "relevant, recent, and accessible" LIS and Com place particular emphasis on recency due to the fast pace of developments in their domains
Completeness and Representativeness	Key and classic works are included, with no major omissions of significant contributions	In His and Phil, there is heightened attention to referencing classical and foundational sources. LIS emphasizes the integration of both foundational and recent sources.
Balance of References	Excessive self-citation is avoided and opposing or alternative views are acknowledged	All fields reject "excessive, limited, or biased referencing" Phil and LIS especially emphasize the importance of fair representation of alternative perspectives
Accuracy and Correctness	References are accurate, complete, and clearly correspond to the claims made in the article	His and Phil emphasize technical precision (e.g., footnotes, translations, phrasing), while Com focuses on alignment between citations and the article's arguments
Compliance with Ethics and Anonymity	References do not reveal the author's identity (in blind review processes) and provide appropriate credit to third parties	Phil places particular emphasis on protecting anonymity in citations. All fields stress the importance of fair and proper attribution
Functionality and Economy of References	Citations strengthen the argumentation, avoiding vague or insufficient references	All fields agree that references must clearly support the article's claims. Phil places particular emphasis on substantiating lines of reasoning

Integrating C4 – Balance and Accuracy of Bibliographic References into article evaluation models is both valuable and complex, particularly when considered across LIS, Communication, History, and Philosophy, and considering existing literature. One major benefit is that it serves as a qualitative marker of scholarly competence. Scholars [33] argue that references should reflect not only familiarity with prior work but also conceptual synthesis and targeted justification. This enables evaluators to detect theoretical gaps or weak disciplinary foundations. Another strength lies in promoting transparency and credibility in scholarly argumentation. Bonaccorsi [30] stresses that citations should substantiate claims and avoid poorly chosen or irrelevant sources, helping prevent "citation inflation" and encouraging precise, justified referencing. Still, modeling this criterion poses challenges. The idea of balance varies by field. in Philosophy, it may involve broad historical coverage and interpretive range, whereas in Communication and LIS, emphasis falls on recency, relevance, and retrievability. Additionally, there's no standardized method to quantify reference quality. Researchers [34] call for assessing the "logical flow and completeness" of references but provide no concrete metric, making human judgment essential, yet potentially inconsistent. Literature also highlights the need to prioritize primary, foundational, and authoritative sources over marginal or purely secondary ones, a distinction especially critical in History, where expert judgment is key. Despite differences, all disciplines recognize the value of bibliographic integrity, supporting both cross-disciplinary standards and field-specific flexibility. When clearly defined, this criterion enhances theoretical depth, methodological soundness, and argumentative clarity.

Table 9. *C5- Compliance with Ethical Standards of Research*

CPE	**C5- Compliance with Ethical Standards of Research**				
Science	**His**	**LIS**	**Com**	**Phil**	**Total**
x̄	5,95	5,6	5,1	4,95	**5,4**
Med	7	5	5	5	**5**
Mo	7	7	5	5	**5**
Σ (x̄ + Med + Mo)	**19,95**	**17,6**	**15,1**	**14,95**	**15,4**
σ	1,54	1,43	0,79	1,32	**1,32**
Final Value = Σ (x̄ + Med + Mo) – σ	**18,41**	**16,17**	**14,31**	**13,63**	**14,07**
Mapping to a 7-Point Importance Scale	**6,44**	**5,65**	**5,00**	**4,77**	**4,92**

C5 - Compliance with Ethical Standards of Research is considered important overall but shows notable variation across disciplines. History records the highest average (5,95) and final score (6,44), reflecting strong adherence to ethical norms. LIS follows (avg. 5,6, final 5,66), while Philosophy scores lowest (avg. 4,95, final 4,77), suggesting looser application or a different conceptual approach to ethics. Communication falls in between (avg. 5,1, final 5,01). History stands out with a median and mode of 7, indicating high reviewer agreement. In contrast, Philosophy and Communication show median and mode at 5, signaling more cautious evaluations. Despite its importance, ethical compliance lacks uniform application and requires tailored

indicators based on research type and disciplinary context.

Table 10. *Proposed Modeling Framework for the 5th Criterion*

Proposed Modeling Framework for the 5th Criterion: Compliance with Ethical Standards of Research		
Evaluated Dimension	**Description**	**Common & Specific Points**
Ethics Committee Approval	Refers to documented approval or a justified exemption from a relevant ethics review board. For example, it checks whether there is an official reference to such a body and/or whether the decision not to submit the study for ethical review is adequately explained	All fields agree on the need for an explicit reference to research ethics committee approval, where required, and for documented informed consent from participants
Informed Consent	Describes consent procedures free from coercion. Indicates whether and how participants' voluntary consent was obtained	Across all four academic fields, the ethical aspect of informed consent is considered fundamental to scientific validity
Data Management and Protection	Implementation of practices to protect personal data, including pseudonymization and anonymity. Describes the nature and storage of data, ensuring privacy is safeguarded	Maintaining ethical integrity, confidentiality and sensitivity to systemic biases are broadly accepted requirements across all fields, in line with the principles of COPE (Committee on Publication Ethics)
Transparency and Open Science	Providing access to data, code, and analytical procedures where possible. For example, files and appendices are shared and they are available to readers or reviewers	This is most evident in His, where transparency and data availability are emphasized, but it is a criterion that can be applied across all disciplines
Conflict of Interest	A complete and honest declaration by the authors, clearly stating any potential financial or personal interests	This dimension is applicable across all academic fields
Academic Integrity	Avoidance of plagiarism, data fabrication/falsification, bias, or concealment of negative results. Proper attribution of sources is ensured. Critical question for peer revieers: are there signs of manipulation or selective reporting?	There is a shared emphasis across all fields on preventing unethical practices such as plagiarism, fraud, duplicate publication, and rejecting articles that violate ethical standards
Conscious Bias Evaluation	Identification of institutional and/or systemic biases, with authors engaging in critical reflection. There should be awareness of potential bias or selective reporting	Sensitivity to systemic bias is especially evident in Com, but it is a broadly accepted requirement across disciplines, in alignment with COPE principles
Journal's Ethical Guidelines	The article complies with the publisher's or journals stated ethical and integrity policies. There should be a clear reference to the journal's ethical standards and/or adherence to COPE best practices	This applies to all academic fields

The discussion on C5 – Compliance with Ethical Standards of Research highlights ethical integrity as a fundamental and non-negotiable condition for the acceptance of scientific work. Comparative analysis across History, Philosophy, Communication, and LIS reveals disciplinary differences in application, but a shared recognition of its core value. Literature strongly supports this criterion. It emphasizes that ethics approval and informed consent are essential, not as formalities but as part of a researcher's responsibility toward participants, the public, and the scientific community [33]. Additionally, it stresses transparency as essential for both ethics and reproducibility [29]. A key strength of this criterion is its potential for relatively objective assessment through documentation, such as ethics approval letters, consent statements, conflict of interest declarations, and data availability, which enhances both trust in the study and its scientific validity, particularly in research involving human or sensitive social subjects. However, challenges remain. Ethical norms vary across disciplines, and in theoretical fields like Philosophy, where human participants are rare, ethical requirements are less formalized, complicating standardization. As scholars note, ethical evaluation must go beyond protocols, addressing systemic biases like the suppression of negative results or confirmation bias [38]. Open science also plays a vital role, with scholars advocating for the publication of raw data and alternative analyses to strengthen ethical responsibility [35]. Literature adds that journal policies themselves should be assessed, placing institutional accountability at the forefront [37]. C5 is a multidimensional criterion with normative weight and universal relevance. Its integration into evaluation models enhances transparency and integrity but requires nuanced, context-sensitive implementation.

Table 11. *C6 - Reliability and Reproducibility of Methodology*

CPE	**C6 - Reliability and Reproducibility of Methodology**				
Science	**Com**	**LIS**	**His**	**Phil**	**Total**
x̄	4,8	5	4,55	4,1	**4,61**
Med	5	5	5	4	**5**
Mo	5	5	5	4	**5**
Σ (x̄ + Med + Mo)	**14,8**	**15**	**14,55**	**12,1**	**14,61**
σ	0,62	0,92	1,19	0,72	**0,92**
Final Value = Σ (x̄ + Med + Mo) – σ	**14,18**	**14,08**	**13,36**	**11,38**	**13,68**
Mapping to a 7-Point Importance Scale	**4,96**	**4,92**	**4,67**	**3,98**	**4,78**

The overall mean score of (x̄ =4,61) suggests that C6 - Reliability and Reproducibility of Methodology is considered of moderate to significant importance. The highest average is recorded in LIS (5), while Philosophy scores lowest (4,1), reflecting differing views on the criterion's relevance. Most fields show a median and mode of 5, indicating consistent recognition, except Philosophy (4), which suggests a more cautious stance. The low standard deviation overall (σ= 0,93), and especially in Communication (σ=0,62) and LIS (σ=0,92), reflects stable reviewer judgments. History receives the highest scaled score (6,44, very important), followed by LIS (5,66) and Communication (5,01). Philosophy again ranks lowest (4,77, moderate importance). The final weighted score across fields is 4,79, near the important threshold.

The review and discussion of key findings related to C6 – Reliability and Reproducibility of Methodology across four disciplines reveal both notable similarities and field-specific differences. These relate to the clarity, documentation, and replicability of methodological processes. Common ground includes a shared emphasis on detailed, transparent, and well-documented methodology to ensure replicability, aligning with standards set by many scholars [29, 33, 36]. All fields stress that studies must allow other researchers to

repeat the process and verify outcomes, echoing Davis et al. [35].

Table 12. *Proposed Modeling Framework for the 6th Criterion*

Proposed Modeling Framework for the 6th Criterion: Reliability and Reproducibility of Methodology		
Evaluated Dimension	**Description**	**Common & Specific Points**
Detailed Methodology Description	The methodology must be clearly and sufficiently detailed to allow replication by other researchers	Common across all fields
Study Design Allowing Replication	The study design and structure should allow repetition with similar results	Common across all fields
Experimental Approach and Sampling	Emphasis on repeated analyses, experiments, and proper sampling to ensure reliability	Present in most fields. His and LIS emphasize experiments and sampling techniques
Validity and Reliability of Conclusions	Assesses whether conclusions are logically and adequately supported by the data	Shared emphasis. All domains link interpretation of conclusions to methodological soundness
Link with Argument or Theoretical Basis	The methodology is assessed alongside the article's argumentation	Field-specific in His where methodology is tied to the strength of the presented argument
Logical Justification of Interpretation	Data interpretation must be logical and well-justified	Field-specific in Phil where justification is treated as a fundamental methodological element
Method–Question Alignment	Methods must be appropriate for the research question	Field-specific in Com where emphasis on matching method to research objective
Documentation of New Methods	New or original methods must be explained thoroughly	Field-specific in LIS
Ethical Approval Reference	Evaluation includes whether ethical approval for the methodology is mentioned	Specifically emphasized in Com
Bias Detection	Potential biases affecting design or conclusions are identified	Explicitly mentioned in His and Com

There is also consensus that methodology must logically connect to research questions and goals, showing that it is an integral, not isolated, part of the research logic. Disciplinary differences emerge in how methodology is interpreted and applied. In History, emphasis is placed on argumentative soundness and adherence to scholarly conventions, with less focus on technical reproducibility. In Philosophy, reproducibility is understood as logical consistency and re-traceability of reasoning rather than empirical repetition, given the field's conceptual nature. Communication stresses empirical grounding, clear methodological structure, sampling procedures, and alignment with research questions, practices that directly reflect scholars' views [36]. LIS highlights technical completeness, especially in detailing tools, software, protocols, and new methods. While reliability and reproducibility are valued across all fields, their interpretation varies. Empirical domains demand methodological precision, whereas theoretical disciplines prioritize coherence and justification. These findings, supported by literature, underscore the need for tailored yet consistent evaluation criteria across research domains.

Table 13. *C7- Significance of the Quality and Clarity of Tables, Graphs and Figures*

CPE	**C7- Significance of the Quality and Clarity of Tables, Graphs and Figures**				
Science	**LIS**	**His**	**Com**	**Phil**	**Total**
x̄	5,05	4,8	4,1	4	**4,48**
Med	5	5,5	4	4	**5**
Mo	6	6	5	4	**5**
Σ (x̄ + Med + Mo)	**16,05**	**16,3**	**13,1**	**12**	**14,48**
σ	0,94	1,54	0,91	0,73	**1,14**
Final Value = Σ (x̄ + Med + Mo) – σ	**15,11**	**14,76**	**12,19**	**11,27**	**13,34**
Mapping to a 7-Point Importance Scale	**5,28**	**5,16**	**4,26**	**3,94**	**4,67**

C7 – Significance of the Quality and Clarity of Tables, Graphs, and Figures, which concerns the quality of visual elements, is rated as important in LIS (Mean: 5,05, Final Score: 5,29) and History (Mean: 4,8, Final Score: 5,17), while in Philosophy it is considered of moderate significance (Mean: 4, Final Score: 3,94). The medians and most frequent values confirm this differentiation, reaching up to 6 in the first two fields. Philosophy shows the lowest standard deviation (0.73), indicating greater consistency among reviewers. Overall, the criterion is seen as important when visual presentation enhances understanding, but its weight should be adapted to each disciplinary context.

The analysis of C7 - Significance of the Quality and Clarity of Tables, Graphs, and Figures, reveals both strong advantages for modeling and challenges requiring consideration. All four fields agree that visual elements are not decorative but functional tools that enhance clarity, comprehension, accessibility, and persuasiveness. This consensus allows the articulation of general modeling principles, including accuracy, contribution to understanding, proper labeling, and avoidance of redundancy. Literature supports these principles by highlighting that graphics emphasize findings of particular importance, contributing to scientific impact [33]. Dhillon argues that figures should be self-contained and understandable without referencing the main text, a key quality criterion [29]. Additionally, scholars stress that layout and labeling strongly influence article assessment [36], while they maintain that visuals should interact with the narrative to enhance coherence [34]. Despite convergence, discipline-specific differences require a flexible model. In History, emphasis is placed on numerical accuracy and ethical image use, addressing manipulation or unauthorized reuse. Philosophy prioritizes accessibility, advocating the use of alt text, especially for disabled readers.

Table 14. *Proposed Modeling Framework for the 7th Criterion*

Proposed Modeling Framework for the 7th Criterion: Significance of the Quality and Clarity of Tables, Graphs and Figures		
Evaluated Dimension	**Description**	**Common & Specific Points**
Contribution to understanding and readability	Visual elements should enhance the clarity and comprehension of the content	Common across all fields
Accuracy and correctness of visual elements	All visual data must be accurate and properly labeled	Common across all fields
Visual elements must have functional value, not decorative	Charts and tables should add value and not be superfluous	Common across all fields
Self-sufficiency of visual elements, without reliance on the main text	Each figure should be understandable on its own, without depending on the main text	Literature reference – Dhillon (2021) /could be applied in all fields
Ethical use of images and avoidance of manipulation	Image manipulation or unauthorized reuse must be avoided	Discipline-specific – His
Accessibility through alt text	Alt text must be included to enhance accessibility	Discipline-specific – Phil
Potential for Improvement and Statistical Accuracy	The presentation must allow for enhancements that increase clarity and statistical consistency	Discipline-specific – Com & LIS
Logical Arrangement and Labeling	Figures must be organized in a logical sequence and properly labeled	Literature-based finding – Brown et al. (2017) / could be applied in all fields
Interaction with the Article's Narrative	Figures and tables should align with the flow of the article's narrative rather than simply repeating it	Literature-based finding – Nicholas & Gordon (2011) /could be applied in all fields

Communication and LIS stress improvability and statistical accuracy, indicating a more technical and empirical orientation (e.g., "whether data can be improved for clarity" or "whether visual statistics are represented accurately"). Therefore, while the criterion is universally accepted, modeling must be adaptable. General dimensions, clarity, accuracy, functionality, should coexist with field-specific indicators such as accessibility or statistical formatting. Ultimately, literature affirms this approach promotes transparency, comparability, and scientific quality, despite its complexity [29, 34, 36].

Table 15. *C8- Relevance and Originality of the Research Question or Topic*

CPE	**C8- Relevance and Originality of the Research Question or Topic**				
Science	**His**	**LIS**	**Com**	**Phil**	**Total**
x̄	4,55	5,1	4,45	4,6	**4,67**
Med	5	4,5	4	4	**4**
Mo	5	4	4	4	**4**
Σ (x̄ + Med + Mo)	**14,55**	**13,6**	**12,45**	**12,6**	**12,67**
σ	1,54	1,21	0,83	1,35	**1,252747**
Final Value = Σ (x̄ + Med + Mo) − σ	**13,01**	**12,39**	**11,62**	**11,25**	**11,42**
Mapping to a 7-Point Importance Scale	**4,55**	**4,33**	**4,06**	**3,93**	**3,99**

C8- Relevance and Originality of the Research Question or Topic is generally evaluated positively (mean score: 4,675), though it is not ranked among the top priorities. The highest average score is observed in LIS (5,1), followed by Philosophy (4,6), History (4,55), and Communication (4,45). The median and most frequent values mostly hover around 4, indicating a moderate level of importance, with History being the only field showing a slightly higher median (5). The average standard deviation (1,25) reveals some divergence in evaluations, particularly in History and Philosophy. The final conversion to a 7-point scale (3,99) places the criterion within the medium importance category. Overall, it is considered important but not critical.

Table 16. *Proposed Modeling Framework for the 8th Criterion*

Proposed Modeling Framework for the 8th Criterion: Relevance and Originality of the Research Question or Topic			
Evaluated Dimension	**Sub-dimension**	**Description**	**Common & Specific Points**
1. Relevance	1.1 The topic is directly related to the journal's field	It addresses current trends and uses keywords associated with the discipline	Common across all fields
	1.2 The research question addresses scientific and/or practical problems	It clearly articulates the research problem and relates to ongoing scientific debates	Applies to His, LIS, Com
	1.3 Addresses a well-documented research need	There is an introduction that demonstrates a gap in the literature or insufficient coverage of the topic	Applies to Phil, LIS
2. Originality	2.1 Introduces new ideas, questions, or methodological approaches	Describes a "new" element in relation to the literature; articulates a different approach	Common across all fields
	2.2 Differs from existing studies	Explicit reference to previous works, clearly demonstrating where the study differs	Common across all fields
	2.3 Demonstrates innovation through comparative justification	References to recent, reputable literature to highlight the difference or improvement	Applies to Phil, Com, LIS
	2.4 Measurable innovation, where applicable	Assessment through tools such as Scopus, Web of Science, citation analysis	Applies to LIS
3. Scientific Value	3.1 The study advances knowledge in the field	Highlights how the article contributes to a theoretical or practical level	Common across all fields
	3.2 The work demonstrates epistemological/conceptual progress	Identified through evaluations "progress" or the introduction of a "new way of thinking"	Applies to Phil, His
4. Review	4.1 Provision of comments	Reviewers offer	Applies to

Process	and constructive feedback by reviewers	well-documented improvement suggestions based on identified strengths and weaknesses	LIS
	4.2 Documentation of originality through the introduction or dedicated section	This evaluates whether the introduction identifies the research need, presents previous work, and highlights the innovative element	Applies to Com, Phil, LIS

The comparative analysis of C8 "Relevance and Originality of the Research Question or Topic" across History, Philosophy, Communication, and LIS reveals both convergence and divergence in evaluative practices. A major point of consensus is the universal acceptance of originality as indispensable: all four disciplines demand that research introduce new perspectives or approaches, a view strongly supported by Dhillon, who emphasizes originality as a critical and measurable evaluative standard [29]. Similarly, relevance emerges as a foundational requirement, even if not always explicitly named. This aligns with bibliographic evidence that relevance underpins the assessment of scholarly work.

Another shared feature is the link between originality and topicality, with evaluators expecting engagement with recent, authoritative scholarship. This reflects scholars' claim that innovation is meaningful only when situated within contemporary debates [29, 30]. Moreover, three fields, namely Philosophy, Communication, and LIS, stress the importance of a structured introduction to document gaps and justify originality, fostering transparency, whereas History relies more on holistic judgment at the review's conclusion.

The differences are most pronounced in LIS, which uniquely integrates citation-based tools, e.g., Scopus, Web of Science, to measure originality. While this enhances objectivity and comparability, it risks undervaluing less visible yet innovative contributions, particularly in the humanities. LIS also stands out for its guiding evaluative function, where reviewer feedback is positioned not merely as judgment but as a developmental tool. This contrasts with the more summative stance in other fields.

Overall, the findings highlight a shared evaluative backbone, namely relevance, originality, and scientific contribution, while also pointing to disciplinary distinctions that suggest pathways for more nuanced and supportive evaluation models [29, 30].

Table 17. *C9- Optimization of the Title, Abstract and Keywords for Search Engines*

CPE	**C9- Optimization of the Title, Abstract and Keywords for Search Engines**				
Science	**LIS**	**Com**	**Phil**	**His**	**Total**
x̄	5,15	4,55	4,35	3,4	**4,36**
Med	5	4,5	4	3	**4**
Mo	6	5	4	3	**4**
Σ (x̄ + Med + Mo)	**16,15**	**14,05**	**12,35**	**9,4**	**12,36**
σ	1,27	0,83	1,42	0,94	**1,27**
Final Value = Σ (x̄ + Med + Mo) – σ	**14,88**	**13,22**	**10,93**	**8,46**	**11,08**
Mapping to a 7-Point Importance Scale	**5,20**	**4,62**	**3,82**	**2,96**	**3,87**

C9 – Optimization of the Title, Abstract, and Keywords for Search Engines is rated as moderately important overall, with an average score of 4,36. Variation across fields is notable. History scores low (3,4), while LIS scores highest (5,15), viewing it as important to very important. The median and most frequent value is 4 in most domains, though extremes range from 3 (History) to 6 (LIS). The overall standard deviation is 1,28, indicating moderate agreement; Communication shows the most consistency (0,83), and Philosophy the least (1,42). The final score, 3,88, falls slightly below the significant threshold. Only LIS exceeds 5, while History remains the least aligned. Overall, SEO-related criteria are moderately valued, especially in technical fields, but require tailored evaluation in more traditional disciplines.

Table 18. *Proposed Modeling Framework for the 9th Criterion*

Proposed Modeling Framework for the 9th Criterion: Optimization of the Title, Abstract and Keywords for Search Engines		
Evaluated Dimension	**Description**	**Common & Specific Points**
Accuracy and Representativeness of the Title	The title must accurately reflect the topic and the research question of the article. As the first point of contact, it should include keywords relevant to the subject	Common across all fields: There is a shared requirement for clarity, representativeness, and inclusion of critical SEO terms
		Field-specific: Com and LIS emphasize the importance of aligning the title with the type of study
Clarity, Conciseness, and Completeness of the Abstract	The abstract should clearly summarize the key aspects of the study (objectives, methodology, main findings) without exaggeration. It functions as an independent tool for understanding and discovering the article	Common across all fields: Emphasis on accuracy and fidelity to the content
		Field-specific – Phil: Focus on aligning the abstract with the introduction and conclusions to enhance discoverability
		Field-specific – His: Emphasis on compliance with technical criteria such as word count limits
Accuracy and Strategic Selection of Keywords	Keywords should align with the research topic and facilitate the article's discoverability through search engines	Common across all fields: Emphasis on accuracy and relevance to the article's content
		Field-specific – LIS: Focus on SEO techniques and alignment with the research question
		Field-specific – Phil: Emphasis on accessibility and the article's overall visibility

The integration of C9 – Optimization of the Title, Abstract, and Keywords for Search Engines into an article evaluation model presents significant advantages, alongside challenges that must be addressed. Benefits include enhanced discoverability and dissemination, recognizing that article success depends not only on internal quality but also on visibility. Alignment of the title, abstract, and keywords with SEO principles, as emphasized by the literature [36, 38], modernizes evaluation systems for today's digital academic ecosystem. The criterion supports assessing communication effectiveness; Scholars argue that the abstract is an autonomous tool for increasing readership and citations [33]. Accurate keyword selection further links article content with search queries, boosting relevance. It also enables

standardization across fields regardless of methodology. Fields like History, Communication, and LIS highlight the need to optimize metadata, making the criterion broadly functional. Challenges include subjectivity, namely evaluators' perceptions of clarity or SEO suitability may vary by discipline or personal style. As literature suggests, balancing scientific precision and readability often requires training. Also, familiarity with SEO tools is not universal, particularly in fields like Philosophy or History, limiting criterion applicability when journal policies do not support it. A further risk is over-technocratization. Over-optimizing for search visibility may prioritize trendy keywords over academic rigor, potentially diluting originality and scientific identity. Incorporating this criterion modernizes and adds strategic depth to scientific evaluation. However, it must be supported by clear application guidelines, evaluator training, and careful balancing of visibility with scholarly integrity to avoid undermining academic values.

Table 19. *C10- Effectiveness of the Introduction in Establishing Research Framework, Originality, and Aims*

CPE	**C10- Effectiveness of the Introduction in Establishing Research Framework, Originality, and Aims**				
Science	**LIS**	**Phil**	**His**	**Com**	**Total**
x̄	4,95	4,1	3,5	3,75	**4,07**
Med	5	4	4	4	**4**
Mo	4	4	4	3	**4**
Σ (x̄ + Med + Mo)	**13,95**	**12,1**	**11,5**	**10,75**	**12,07**
σ	1,15	1,07	1,15	0,85	**1,17**
Final Value = Σ (x̄ + Med + Mo) – σ	**12,8**	**11,03**	**10,35**	**9,9**	**10,90**
Mapping to a 7-Point Importance Scale	**4,48**	**3,86**	**3,62**	**3,46**	**3,81**

C10- Effectiveness of the Introduction in Establishing Research Framework, Originality, and Aims is rated at the upper edge of moderate importance, with an overall average of 4,075. The highest score appears in LIS (4,95), indicating strong appreciation of the introduction's role. The median and most frequent score are both 4, showing general agreement among reviewers. The overall standard deviation is 1,17, suggesting moderate variability; Communication shows the most consistency (0,85), while History and LIS both register higher variability (1,15). The final 7-point scale score is 3,82, placing the criterion just below moderate significance. LIS stands out (4,48), nearly reaching the important range, while Communication is slightly lower (3,47). Overall, the introduction is viewed positively but not critically, with its value varying across fields, most notably emphasized in LIS for its role in defining scope and innovation.

Table 20. *Proposed Modeling Framework for the 10th Criterion*

Proposed Modeling Framework for the 10th Criterion: Effectiveness of the Introduction in Establishing Research Framework, Originality, and Aims			
Evaluated Dimension	**Sub-dimension**	**Description**	**Common & Specific Points**
1. Framing the Research	1.1 Definition of framework and relevance	The introduction clearly establishes the theoretical or practical framework and explains why research is important	Common: All disciplines agree on the need for a theoretical framework (Aggarwal et al., 2022) Specific: In Phil and Com, this is linked to audience targeting
	1.2 Link to existing problems or scientific questions	The study is positioned within an existing need or scholarly discussion in the field	Common: All disciplines require contextual grounding Specific: In Com, there's an expectation to link the topic with public/social discourse
2. Originality and Knowledge Gaps	2.1 Identification of knowledge gap or issue	The introduction convincingly shows where the issue has not been addressed and how the study intervenes	Common: All fields expect a literature review to identify the gap Specific: Phil – emphasis on theoretical contribution; LIS – focus on identifying missing references
	2.2 Statement of innovation or added value	The introduction clarifies the study's contribution (theoretical, methodological, or practical)	Common: Clear statement of the contribution is required Specific: Phil – emphasis on conceptual differentiation; LIS – alignment with results; His – less structured, more judgment-based justification
3. Aims and Research Questions	3.1 Clear statement of objectives or hypotheses	The study's aims are explicitly presented without ambiguity	Common: All disciplines require clearly stated aims (Aggarwal et al., 2022) Specific: In Phil and Com, goal formulation is tied to rhetorical strategy and audience
	3.2 Link between aims, problem, and framework	The aims are logically integrated into the introduction's rationale.	Common: Coherence in the introduction is expected Specific: In LIS, emphasis is placed on aligning stated aims with findings and conclusions
4. Use of Literature	4.1 Reference to recent and relevant sources	The literature used is sufficient, valid, and up to date	Common: The importance of relevant literature is universally recognized Specific: In LIS, highly up-to-date references are expected, with more rigorous source evaluation
	4.2 Check for missing references or unsubstantiated claims	Critical omissions or insufficiently supported points are identified	Common: Proper reference is a core element of validity Specific: LIS emphasizes analytical coverage and relevance of sources; Phil and His assess literature more qualitatively and interpretively

The analysis of C10- Effectiveness of the Introduction in Establishing Research Framework, Originality, and Aims, in comparison with the literature [33], highlights critical aspects for shaping a reliable and cross-disciplinary

evaluation model. All fields agree that the introduction must clearly place the study within an appropriate theoretical or scientific framework, confirming scholars' assertion that the introduction sets the stage for the research [33]. Likewise, there is a common requirement for an explicit statement of objectives or research questions, which ensures transparency and facilitates understanding of the research intent [33]. The use of relevant literature, not necessarily exhaustive but sufficient, is also considered essential to justify the existence of a problem or knowledge gap that the study seeks to address. Moreover, the introduction does not merely function as a preamble, but as a strategic point for framing originality, clarifying the study's contribution compared to existing knowledge. Clarity, structure, and coherence are judged as core qualities of the introduction, as they define its informative and orienting role [33]. However, there are also notable differences. In Philosophy and Communication, particular emphasis is placed on audience targeting, embedding the introduction within a rhetorical framework. There is also a clear expectation for a structured format, ending with the articulation of research objectives. LIS emphasizes the critical selection of bibliographic sources, with an increased demand for recency and documentation, and highlights the alignment of the introduction's objectives with the study's findings, strengthening the article's internal consistency. In contrast, History presents a less structured approach, where final judgment prevails over initial grounding. The introduction is identified as a crucial part of the article, with fundamental shared requirements and specific disciplinary differences that can be incorporated into the proposed evaluation model.

Table 21. *C11- Coherence and Logic of the Article's Argument*

CPE	**C11- Coherence and Logic of the Article's Argument**				
Science	**His**	**LIS**	**Com**	**Phil**	**Total**
x̄	4,8	4,55	3,25	3,65	**4,0625**
Med	6	4	3	3	**3**
Mo	6	6	3	3	**3**
Σ (x̄ + Med + Mo)	**16,8**	**14,55**	**9,25**	**9,65**	**10,06**
σ	1,54	1,39	0,72	1,23	**1,38**
Final Value = Σ (x̄ + Med + Mo) − σ	**15,26**	**13,16**	**8,53**	**8,42**	**8,68**
Mapping to a 7-Point Importance Scale	**5,34**	**4,60**	**2,98**	**2,94**	**3,038**

C11- Coherence and Logic of the Article's Argument is evaluated differently across fields. The highest average score is observed in History (4,8), indicating strong emphasis on argumentative coherence, followed by LIS (4,55). In contrast, Philosophy (3,65) and Communication (3,25) show lower averages, resulting in an overall mean of 4,06, suggesting moderate significance. Median and mode values are highest in History and Information Science, while both are 3 in Philosophy and Communication, confirming a more reserved stance. Standard deviations range from 0,72 (Communication) to 1,54 (History), reflecting varying consensus. Only History rates the criterion as clearly important (5,34), while Philosophy and Communication remain at low levels (~2,95).

Table 22. *Proposed Modeling Framework for the 11th Criterion*

Proposed Modeling Framework for the 11th Criterion: Coherence and Logic of the Article's Argument		
Evaluated Dimension	**Description**	**Common & Specific Points**
Logical Alignment of Conclusions with Arguments and Evidence	The conclusions of the article should be firmly grounded in the arguments and evidence developed throughout the text. Strong, coherent reasoning is essential to ensure that conclusions are not only supported by data but also emerge logically from the progression of the argument	Common across all fields
Logical and Coherent Development of the Argument	The structure of the argument should be well-organized, coherent, and present a logical flow of ideas	Common across all fields
Dentification of Logical and Conceptual Fallacies	The argument should avoid unclear or invalid reasoning, factual errors, and unsound arguments	Common in Phil, Com, LIS
Well-Structured and Logically Developed Argument Without Exaggerated or Unjustified Conclusions	The argument should not lead to conclusions that are insufficiently supported by the presented data	Field-specific in His
Assessing Topic Alignment with the Journal's Profile as a Prerequisite for Argument Validation	Before evaluating the logical coherence and quality of the argumentation, it is essential to determine whether the research topic aligns with the mission and disciplinary focus of the journal. Thematic relevance serves as the initial filter that allows the argument to be meaningfully contextualized within the framework in which it will be read	In Com, alignment of the topic with the journal's purpose and focus is considered crucial for the validity of the argumentative approach
Consistency of Findings with the Author's Stated Expectations as an Indicator of Argumentative Reliability	The evaluation of scientific argumentation includes examining whether the study's findings are consistent with the declared aims and expectations of the author. A clear connection between objectives, results, and conclusions strengthens the logical validity of the argument and the transparency of the research process	In LIS this point is of particular importance, as such consistency enhances the credibility of the final conclusions

The modeling of C11- Coherence and Logic of the Article's Argument, offers notable advantages for cross-disciplinary evaluation, yet presents critical challenges. A key strength lies in the broad consensus across disciplines that an article's conclusions must align with the presented data and arguments. There is also shared recognition of the need for a logically structured and coherent argument, which enhances scientific communication. Furthermore, identifying unclear reasoning, factual errors, or invalid claims is considered essential in almost all domains, allowing these aspects to be integrated into a shared model. Literature supports these core expectations emphasizing that alignment between research questions, methods, findings, and conclusions is central to the logical integrity of a paper [31]. It also highlights the role of the introduction in establishing a logical foundation [33] and underscores the importance of sound and valid evidence for strong argumentation [29]. However, challenges arise from disciplinary differences. In History, reviewers stress avoiding unjustified conclusions, reflecting the field's emphasis on evidence-based interpretation. Philosophy focuses on conceptual clarity and the identification of ambiguities.

Communication introduces institutional context by evaluating topic alignment with a journal's mission. LIS emphasizes consistency between findings and the author's expectations. These divergences complicate a unified model. As scholars [34] warn, neglecting contradictions or alternative interpretations weakens an article's argument [34]. Therefore, modeling must be flexible, grounded in common standards like argument-data alignment, but adaptive to each discipline's unique evaluative lens, to ensure transparency and validity.

V. Conclusions

The identification and thematic analyses of criteria C1–C11 provide substantial insights into the research questions posed. Considering the uneven distribution and differentiation of sources across fields, we conclude that the findings clearly illustrate similarities across disciplines: all academic communities emphasize transparency, validity, coherence, and ethical integrity as fundamental elements of article evaluation. For example, both C1 (Adequacy of Data) and C2 (Consistency of Conclusions) reveal a cross-disciplinary commitment to logical alignment between evidence and claims. At the same time C3 (Clarity and Readability) and C7 (Tables and Figures) confirm universal expectations for accessible and well-structured communication.

Second, the analyses also reveal disciplinary differences in evaluative emphasis. Communication prioritizes ethical responsibility and narrative accessibility. Library and Information Science stresses methodological precision, bibliographic balance, and technical reproducibility. History emphasizes evidence-based interpretation and avoidance of unjustified conclusions. Philosophy values conceptual clarity and argumentative coherence over empirical reproducibility. These differences show that the epistemological traditions of each field shape evaluation processes.

Third, the review highlights how scientific culture is embedded in peer-review guidelines. Communication reflects its applied, socially engaged orientation through ethical standards and data transparency. History and Philosophy reveal more interpretive and judgment-based criteria, privileging conceptual soundness and historical breadth. Meanwhile, Library and Information Science, situated between the sciences and humanities, combines empirical rigor with theoretical synthesis. Thus, the evaluative frameworks are not neutral but mirror disciplinary identities.

Finally, the synthesis indicates that a common, interoperable, and unbiased review model is indeed feasible, provided it incorporates both shared foundations and adaptive flexibility. The core standards, reliability of data, logical consistency, ethical compliance, clarity of presentation, and bibliographic integrity, can serve as universal anchors. At the same time, field-specific indicators (e.g., citation-based innovation tools in Library and Information Science, narrative coherence in Communication, conceptual rigor in Philosophy, and evidential robustness in History) must be preserved to ensure disciplinary autonomy and methodological integrity.

In sum, they identify broad cross-disciplinary similarities, pinpoint distinct differences shaped by scientific cultures, and suggest how a balanced evaluation model can integrate both dimensions. What remains to be explored—potentially as a twelfth criterion—is the role of Artificial Intelligence in shaping evaluation processes, an emerging theme with insufficient bibliography but growing relevance for the future of peer review.

References

[1] Tennant, J. P., & Ross-Hellauer, T. (2020). The limitations to our understanding of peer review. *Research integrity and peer review*, *5*(1), 6. https://doi.org/10.1186/s41073-020-00092-1

[2] Hamilton, D. G., Fraser, H., Hoekstra, R., & Fidler, F. (2020). Meta-Research: Journal policies and editors' opinions on peer review. *Elife*, *9*, e62529. https://doi.org/10.7554/eLife.62529

[3] Karhulahti, V. M., & Backe, H. J. (2021). Transparency of peer review: a semi-structured interview study with chief editors from social sciences and humanities. *Research Integrity and Peer Review*, *6*(1), 13. eer Review (2021) 6:13 https://doi.org/10.1186/s41073-021-00116-4

[4] Ross-Hellauer, T., & Horbach, S. P. (2024). Additional experiments required: A scoping review of recent evidence on key aspects of Open Peer Review. *Research Evaluation*, *33*, rvae004. https://doi.org/10.1093/reseval/rvae004

[5] Zhang, Y., & Wang, Y. (2024). Understanding delays in publishing interdisciplinary research. *Information Processing & Management*, *61*(5), 103826. https://doi.org/10.1016/j.ipm.2024.103826

[6] Okamura, K. (2019). Interdisciplinarity revisited: evidence for research impact and dynamism. *Palgrave Communications*, *5*(1). https://doi.org/10.1057/s41599-019-0352-4

[7] Newman, J. (2024). Promoting interdisciplinary research collaboration: A systematic review, a critical literature review, and a pathway forward. *Social Epistemology*, *38*(2), 135-151. https://doi.org/10.1080/02691728.2023.2172694

[8] Kim, K., Kogler, D. F., & Maliphol, S. (2024). Identifying interdisciplinary emergence in the science of science: combination of network analysis and BERTopic. *Humanities and Social Sciences Communications*, *11*(1), 1-15. https://doi.org/10.1057/s41599-024-03044-y

[9] Halliday, L. (2001). Scholarly communication, scholarly publication and the status of emerging formats. *Information research*, *6*(4), 6-4. https://informationr.net/ir/6-4/paper111.html

[10] Stock, W. G., & Stock, M. (2013). *Handbook of information science*. Walter de Gruyter.

[11] Eisenberg, M. B. (2008). Information literacy: Essential skills for the information age. *DESIDOC journal of library*

& information technology, *28*(2), 39-47. https://www.indianjournals.com/ijor.aspx?target=ijor:dbit&volume=28&issue=2&article=005&type=pdf

[12] Floridi, L. (2015). *The onlife manifesto: Being human in a hyperconnected era*. Springer nature. https://library.oapen.org/bitstream/handle/20.500.12657/28025/1001971.pdf

[13] Van Dijck, J., Poell, T., & De Waal, M. (2018). *The platform society: Public values in a connective world*. Oxford university press.

[14] Radsch, C. (2014). World trends in freedom of expression and media development. *World Trends in Freedom of Expression and Media Development. Ed. Courtney C. Radsch. UNESCO: Paris, France*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2424905

[15] Ruben, B. D. (2017). *Between communication and information*. Routledge. https://doi.org/10.4324/9781351294720

[16] Waisbord, S. (2019). *Communication: A post-discipline*. John Wiley & Sons.

[17] Song, H., Eberl, J. M., & Eisele, O. (2020). Less fragmented than we thought? Toward clarification of a subdisciplinary linkage in communication science, 2010–2019. *Journal of communication*, *70*(3), 310-334. https://doi.org/10.1093/joc/jqaa009

[18] Breuer, J., & Haim, M. (2024). Are we replicating yet? Reproduction and replication in communication research. *Media and Communication*, *12*. https://doi.org/10.17645/mac.8382

[19] Ivory, J. D. (2024). Remembering reasons for reform: A more replicable and reproducible communication literature without the rancor. *Media and Communication*, *12*. https://doi.org/10.17645/mac.7852

[20] Hammarfelt, B., Hammar, I., & Francke, H. (2021). Ensuring quality and status: peer review practices in Kriterium, a portal for quality-marked monographs and edited volumes in Swedish SSH. *Frontiers in Research Metrics and Analytics*, *6*, 740297. https://www.cogitatiopress.com/mediaandcommunication/article/view/7852

[21] Müller, K., Salö, L., & Sörlin, S. (2024). Quality from within: Entry points to research quality in the humanities. *Research Evaluation*, *33*, rvae029. https://doi.org/10.1093/reseval/rvae029

[22] Heesen, R., & Bright, L. K. (2021). Is peer review a good idea?. *The British Journal for the Philosophy of Science*, *72*(3), 635-663. https://doi.org/10.1093/bjps/axz029

[23] Pickard AJ. (2013). Historical research. In: *Research Methods in Information*. Facet; 2013:167-178. https://doi.org/10.29085/9781783300235.019

[24] Sytsma, J., & Livengood, J. (2015). *The theory and practice of experimental philosophy*. Broadview Press.

[25] Cova, F., Strickland, B., Abatista, A., Allard, A., Andow, J., Attie, M., ... & Zhou, X. (2021). Estimating the reproducibility of experimental philosophy. *Review of Philosophy and Psychology*, *12*(1), 9-44. https://doi.org/10.1007/s13164-018-0400-9

[26] Andow, J. (2016). Qualitative tools and experimental philosophy. *Philosophical Psychology*, *29*(8), 1128-1141. https://doi.org/10.1080/09515089.2016.1224826

[27] Li, J., & Zhu, X. (2023). Twenty years of experimental philosophy research. *Metaphilosophy*, *54*(1), 29-53. https://doi.org/10.1111/meta.12602

[28] Spencer, R. (2014). Philosophical Approaches to Qualitative Research Renée Spencer, Julia M. Pryce, and Jill Walsh. *The Oxford handbook of qualitative research*, 81. [Full access]

[29] Dhillon, P. (2021). How to be a good peer reviewer of scientific manuscripts. *The FEBS journal*, *288*(9), 2750-2756. https://febs.onlinelibrary.wiley.com/doi/full/10.1111/febs.15705

[30] Bonaccorsi, A. (2018). Peer review in social sciences and humanities. Addressing the interpretation of quality criteria. In *The Evaluation of Research in Social Sciences and Humanities: Lessons from the Italian Experience* (pp. 71-101). Cham: Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-319-68554-0_4

[31] Haines, S. T., Baker, W. L., & DiDomenico, R. J. (2017). Improving peer review: What journals can do. *American Journal of Health-System Pharmacy*, *74*(24), 2086-2089. https://academic.oup.com/ajhp/article-abstract/74/24/2086/5102718

[32] Bornmann, L. (2011). Scientific peer review. *Annual review of information science and technology*, *45*(1), 197-245. https://dl.acm.org/doi/abs/10.5555/2766865.2766877

[33] Aggarwal, R., Louie, A. K., Morreale, M. K., Balon, R., Beresin, E. V., Coverdale, J., & Brenner, A. M. (2022). On the art and science of peer review. *Academic Psychiatry*, *46*(2), 151–156. https://doi.org/10.1007/s40596-022-01608-1

[34] Nicholas, K. A., & Gordon, W. S. (2011). A quick guide to writing a solid peer review. *Eos, Transactions American Geophysical Union*, *92*(28), 233-234. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011EO280001

[35] Davis, W. E., Giner-Sorolla, R., Lindsay, D. S., Lougheed, J. P., Makel, M. C., Meier, M. E., ... & Zelenski, J. M. (2018). Peer-review guidelines promoting replicability and transparency in psychological science. *Advances in Methods and Practices in Psychological Science*, *1*(4), 556-573. https://journals.sagepub.com/doi/full/10.1177/2515245918806489

[36] Brown, L. M., David, E. A., Karamlou, T., & Nason, K. S. (2017). Reviewing scientific manuscripts: A comprehensive guide for peer reviewers. *The Journal of*

[37] *thoracic and cardiovascular surgery*, *153*(6), 1609-1614. https://www.jtcvs.org/article/S0022-5223(17)30250-7/fulltext

[38] Seeber, M. (2020). How do journals of different rank instruct peer reviewers? Reviewer guidelines in the field

of management. *Scientometrics*, *122*(3), 1387-1405. https://link.springer.com/article/10.1007/s11192-019-03343-1

[39] Ali, P. A., & Watson, R. (2016). Peer review and the publication process. *Nursing Open*, *3*(4), 193–202. https://doi.org/10.1002/nop2.51

[40] Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14-26. https://journals.sagepub.com/doi/10.3102/0013189X033007014

[41] Mayring, P. (2014). *Qualitative content analysis: theoretical foundation, basic procedures and software solution*. [Inproceedings]. Retrieved from https://www.ssoar.info/ssoar/bitstream/handle/document/39517/ssoar-2014-mayring-Qualitative_content_analysis_theoretical_foundation.pdf

[42] Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288. https://journals.sagepub.com/doi/10.1177/1049732305276687

[43] Zandvanian, A., & Daryapoor, E. (2013). Mixed methods research: A new paradigm in educational research. *Journal of Educational and Management Studies*, *3*(4), 525-531. J._20Educ._20Manage._20Stud.__2034525-531_202013_20-libre.pdf

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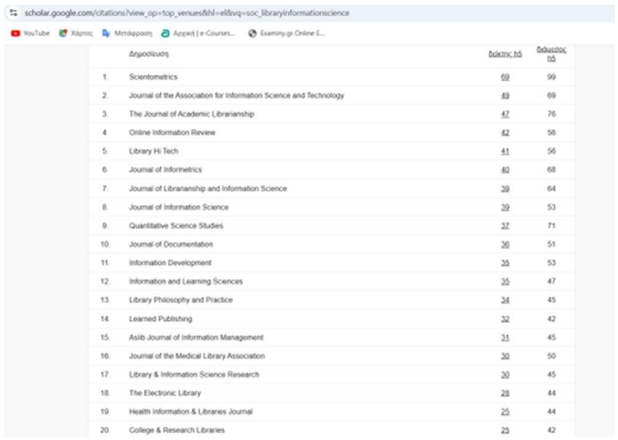
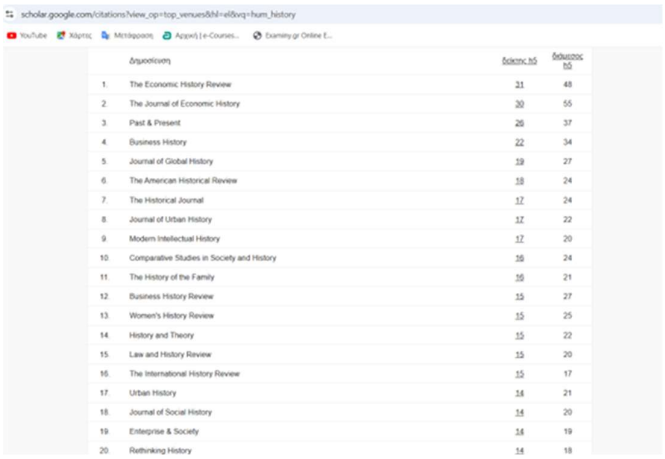
ANNEX



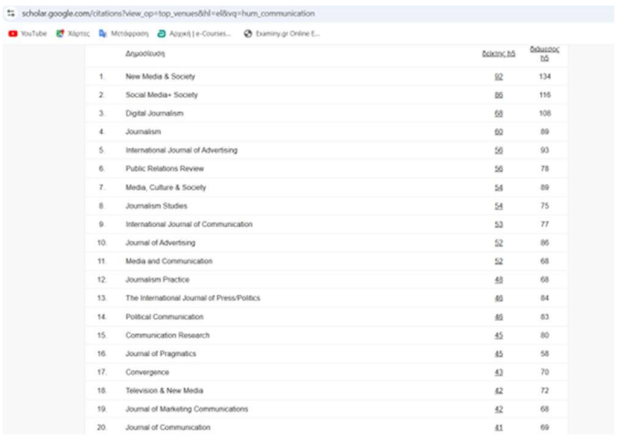
	Δημοσίευση	Δείκτης h5	Διάμεσος h5
1.	Scientometrics	69	99
2.	Journal of the Association for Information Science and Technology	69	69
3.	The Journal of Academic Librarianship	47	76
4.	Online Information Review	42	56
5.	Library Hi Tech	41	56
6.	Journal of Informetrics	40	68
7.	Journal of Librarianship and Information Science	39	64
8.	Journal of Information Science	39	53
9.	Quantitative Science Studies	37	71
10.	Journal of Documentation	36	51
11.	Information Development	35	53
12.	Information and Learning Sciences	35	47
13.	Library Philosophy and Practice	34	45
14.	Learned Publishing	32	42
15.	Aslib Journal of Information Management	31	45
16.	Journal of the Medical Library Association	30	50
17.	Library & Information Science Research	30	45
18.	The Electronic Library	28	44
19.	Health Information & Libraries Journal	25	44
20.	College & Research Libraries	25	42

Fig. 6*. Top 20 Journals in LIS according to Gogle Scholar Metrics.*



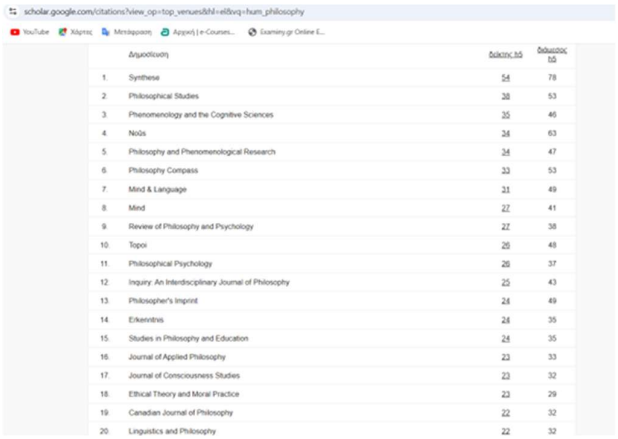
	Δημοσίευση	Δείκτης h5	Διάμεσος h5
1.	The Economic History Review	31	48
2.	The Journal of Economic History	30	55
3.	Past & Present	26	37
4.	Business History	22	34
5.	Journal of Global History	19	27
6.	The American Historical Review	18	24
7.	The Historical Journal	17	24
8.	Journal of Urban History	17	22
9.	Modern Intellectual History	17	20
10.	Comparative Studies in Society and History	16	24
11.	The History of the Family	16	21
12.	Business History Review	15	27
13.	Women's History Review	15	25
14.	History and Theory	15	22
15.	Law and History Review	15	20
16.	The International History Review	15	17
17.	Urban History	14	21
18.	Journal of Social History	14	20
19.	Enterprise & Society	14	19
20.	Rethinking History	14	18

Fig. 5*. Top 20 Journals in His according to Google Scholar Metrics.*



	Δημοσίευση	Δείκτης h5	Διάμεσος h5
1.	New Media & Society	92	134
2.	Social Media+ Society	86	116
3.	Digital Journalism	68	108
4.	Journalism	60	89
5.	International Journal of Advertising	56	93
6.	Public Relations Review	56	78
7.	Media, Culture & Society	54	89
8.	Journalism Studies	54	75
9.	International Journal of Communication	53	77
10.	Journal of Advertising	52	86
11.	Media and Communication	52	68
12.	Journalism Practice	49	68
13.	The International Journal of Press/Politics	46	84
14.	Political Communication	46	83
15.	Communication Research	45	80
16.	Journal of Pragmatics	45	58
17.	Convergence	43	70
18.	Television & New Media	42	72
19.	Journal of Marketing Communications	42	68
20.	Journal of Communication	41	69

Fig. 8. *Top 20 Journals in Com according to Google Scholar Metrics.*



	Δημοσίευση	Δείκτης h5	Διάμεσος h5
1.	Synthese	54	78
2.	Philosophical Studies	38	53
3.	Phenomenology and the Cognitive Sciences	35	46
4.	Noûs	34	63
5.	Philosophy and Phenomenological Research	34	47
6.	Philosophy Compass	33	53
7.	Mind & Language	31	49
8.	Mind	27	41
9.	Review of Philosophy and Psychology	27	38
10.	Topoi	26	48
11.	Philosophical Psychology	26	37
12.	Inquiry: An Interdisciplinary Journal of Philosophy	25	43
13.	Philosopher's Imprint	24	49
14.	Erkenntnis	24	35
15.	Studies in Philosophy and Education	24	35
16.	Journal of Applied Philosophy	23	33
17.	Journal of Consciousness Studies	23	32
18.	Ethical Theory and Moral Practice	23	29
19.	Canadian Journal of Philosophy	22	32
20.	Linguistics and Philosophy	22	32

Fig. 7*. Top 20 Journals in Phil according to Google Scholar Metrics.*

Journal of Integrated Information Management electronic journal

Exploring Problem-Based Learning Impact on Students' Motivation and Engagement in an e-Course Utilizing Microsoft Teams

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Abstract:

Purpose *- The COVID-19 pandemic has rapidly accelerated the implementation of e-learning across all levels of education. However, maintaining high levels of student motivation and engagement is a real challenge in a Technology-Enhanced Learning Environment (TELE), as the use of technology alone is a significant source of distraction. To address this challenge, at the Department of Business Administration at the University of West Attica, an e-course that utilizes a Problem-Based Learning (PBL) method that was delivered via the Microsoft Teams platform, was designed and implemented. Drawing on this conceptual framework, the primary aim of this study is to investigate the effect of PBL on students' motivation and engagement, as well as to explore students' perceptions of the PBL method.*

Design/methodology/approach *- A quasi-experimental pretest–posttest design was adopted in this study. Data were collected from 162 students using Microsoft Teams analytics and the Motivated Strategies for Learning Questionnaire (MSLQ), which was administered both before and after the completion of the e-course. To assess students' motivational orientations, a modified version of the MSLQ was employed, incorporating dimensions such as intrinsic goal orientation, extrinsic goal orientation, and self-efficacy for learning and performance. Students' perceptions of the PBL method were evaluated through open-ended questions, and their responses were analyzed using an inductive content analysis technique.*

Findings *- The analysis of the results reveals that our proposed e-course design approach enhances students' intrinsic motivation, self-efficacy, and engagement. Additionally, these findings are further supported by students' perceptions of working with the PBL method.*

Originality/value *- This study, despite its limitations, provides valuable insights into the limited research on the customization of Microsoft Teams platform from a pedagogical perspective to facilitate complex teaching methods, such as the PBL method.*

Index Terms — Problem-Based Learning (PBL); motivation; engagement; critical thinking; Microsoft Teams; Motivation Strategies for Learning Questionnaire (MLSQ)

I. Introduction

The epidemic of the novel coronavirus strain, 2019-nCoV, which emerged in January 2020 in China [1], swiftly spread worldwide, negatively impacting not only health and the economy but also almost every aspect of human activity. However, this crisis also gave rise to new opportunities for innovation and creativity. Particularly in the field of education, educational institutions worldwide have been called upon to reassess their operational methods. In the case of Greece, academic institutions have rapidly adapted to the demands of the new era since September 2020 by offering online courses through Learning Management Systems (LMS) and video conferencing tools.

The introduction of distance education posed new challenges. Specifically, personal interaction is now influenced by the capabilities of digital communication and collaboration tools, which can limit social interaction [2] and contribute to a sense of isolation among learners [3].

During and after the Covid-19 pandemic, when distance education was widely implemented, first-year students faced an even greater challenge. They lacked the opportunity to meet their peers and instructors face-to-face, which hindered their ability to develop a robust social network. Conditions of reduced social interaction, as documented in the literature, have been found to lead to a decrease in learning motivation [4], [5]. Building upon the aforementioned issues, we have developed an innovative approach for an e-course based on the Problem-Based Learning method in order to enhance students' motivation and engagement.

II. THEORETICAL BACKGROUND

Problem-Based Learning

Problem-Based Learning (PBL) is a student centered method that involves learners actively engaging in the process of solving meaningful, semi-structured, open - ended problems. This pedagogical method emphasizes learning through the process of problem-solving and cultivates high - order thinking skills. Rooted in the progressive ideas of John Dewey [6], [7], PBL promotes learning environments that enhance students' critical thinking, autonomy, and the ability to work both independently and in groups. PBL originated in the late 1960s at the Faculty of Health Sciences at McMaster University in Canada. It falls under the category of learner-centered learning methods, with the educator primarily functioning as a facilitator throughout the entire process. Additionally, the role of the educator focuses on guiding work groups and familiarizing them with the stages of the research methodology. Barrow [8] emphasized that PBL changes the role of the student from a knowledge receiver to an active learner through real-world problem solving. Since then, this methodology has been adopted in many fields, including medicine, nursing, and pharmacy.

The PBL method was not developed to facilitate the transmission of a large volume of cognitive information, a process that is more effectively served through strategies such as demonstration or presentation. On the contrary, through PBL, learners assume a more active and autonomous role in the learning process, developing the 4c's of 21st-century skills (collaboration, communication, creative thinking, critical thinking).

According to research findings [9], PBL plays a significant role in shaping learners' attitudes towards the learning process. Specifically, the relevant literature [10] indicates that learners who participate in courses structured based on the PBL method develop a positive attitude towards learning. This is in contrast to learners who attend classes based on "traditional" teacher-centered teaching methods, where strategies such as lectures, presentations, and demonstrations are dominant. Furthermore, in quasi-experimental studies [11], [12], [13] that applied the PBL method, an increase in learners' intrinsic motivation was observed, , while external motivation remained unchanged. Chung [14] proved that a structured implementation of PBL protocols in higher education supports the development of learners' motivation and critical thinking. It also fosters the transfer of theoretical knowledge into real-life contexts, particularly in the field of community-based rehabilitation.

However, it should be noted that in the initial stages of implementing the PBL method, learners may experience emotions associated with trauma, such as shock, rejection, intense reactions, resistance, and acceptance. This is due to the radical changes taking place in the learning environment, as they transition from lectures to research methodology and group work [15]. And only when learners overcome these intermediate stages and reach acceptance, will they realize that they have attained higher levels of performance.

As shown in **Fig. 1**, a PBL session begins with presenting a complex problem to a group of students, who gather additional information through experiments or research. During the investigation, students pause to review the data, pose questions and develop hypotheses about the problem's theme. They then discover ideas that require further learning aimed at solving the problem. Next, students split up to independently research the specific issues before regrouping to share their findings, reassess assumptions, and develop new ones. At the end, they engage in reflection and feedback to evaluate their understanding and progress toward a solution [16].

***Fig. 1**. The PBL cycle [17]*

Motivation

Motivation is a central concept in both educational and psychological research. Initially, the term referred to the internal state that motivates an individual to take action and maintain focus on specific activities [18]. Motivation is widely acknowledged as an internal condition shaped by personal and environmental influences. As noted by Sirhan et al. [19], it stems from a combination of internal elements and external stimuli, including reinforcement mechanisms. These interacting factors activate specific behaviors that aim to close the gap between an individual's current state and their desired goals [20]. In this context, motivation functions as a psychological force that energizes and directs behavior toward acquiring knowledge. According to Bishara [21], this is achieved through purposeful actions that lead to specific learning outcomes.

Building upon this foundation, Deci and Ryan [22] formulated an initial distinction between internal (intrinsic) and external (extrinsic) motivations. The term "internal" (or intrinsic) motivation refers to the internal process that guides an individual to choose to engage with a specific topic or learning activity. Learners with an intrinsic orientation towards goals are characterized by a genuine interest in the learning process and a desire to enhance their knowledge in the subject matter itself, without relying on external rewards

[23].

The term "external" (or extrinsic) motivation refers to the influence of external factors that guide an individual to engage in a specific learning process. External motivations include various types of positive reinforcements, such as recognition of effort or praise, as well as negative reinforcements, such as reprimands or punishments [24].

The role of motivation, both internal and external, is particularly significant in the learning process. Motivation enhances students' understanding that learning builds upon their capabilities and functions as an internal force guiding their actions. It encourages them to engage with what they consider meaningful and important, ultimately leading to improved academic performance [25]. Specifically, motivation is linked not only to the dedication of learners but also to their learning performance [26]. Furthermore, similar to motivation, self-efficacy also plays a significant role in the entire learning process. As defined by Bandura [27], self-efficacy refers to an individual's belief in their own ability to succeed in specific situations or accomplish specific tasks. According to Bong [28], self-efficacy is the second most crucial factor, after skills, in predicting academic performance. In detail, students with high self-efficacy believe that success and failure are the result of their own behaviors and abilities, rather than external factors. Consequently, students demonstrate increased engagement and exert more effort in their educational endeavors, thereby resulting in improved academic performance.

Microsoft Teams

Microsoft Teams (MS Teams) application was developed by Microsoft in 2016 and is a part of the Microsoft 365 product family. It is a digital communication and collaboration platform that effectively combines chat, video conferencing, and Microsoft's digital applications into a unified workspace. Its functionality is primarily based on the chat-centric workplace process. Each user of MS Teams is part of the larger community of certified Office 365 users and can create their own team or become a member of other teams comprised of certified users. When creating working groups, a default general communication channel is established. Users can utilize this channel to post messages, read announcements, store their work in cloud storage, conduct meetings, and add both Microsoft and third-party applications.

The MS Teams platform was chosen by Wester Attica University to implement modern distance education during the Covid-19 period. It was used alongside the Open e-Class and Moodle learning management systems, which were already being utilized to support asynchronous online learning.

Many tertiary education institutions worldwide use the MS Teams platform, and they have reported encouraging results. The platform offers several significant advantages, including reliability, the ability to share educational materials, and flexibility in terms of accessing recorded digital lessons at any time and from any location [29]. However, regardless of the platform used, the educator plays the most important role in developing positive attitudes among learners towards online learning [30].

III. METHOD

Research model

The research method employed in this study was a quasi-experimental one-group pretest-posttest research design. The quasi-experimental research design shares similarities with experimental research, but it does not meet the criteria for a true experimental design. While the independent variable is manipulated, participants are not randomly assigned to different conditions or orders of conditions [31]. However, most empirical studies in the field of education are quasi-experimental rather than experimental [32]. The selection of the quasi-experimental research design was carried out for purely practical reasons, as random assignment was not feasible. In a one-group pretest-posttest research design, one or more dependent variables are measured twice: once before and once after the treatment is introduced. The analysis of the differences between pretest and posttest scores indicates the impact of the experimental intervention. In our study, we conducted a quasi-experimental research for a duration of 7 weeks. The research procedure was as follows (**Fig. 2**).

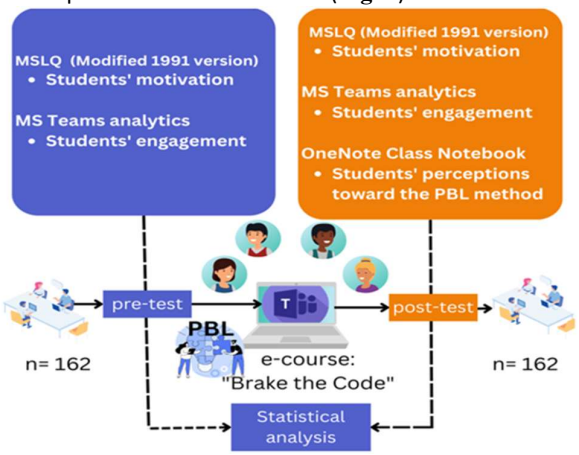

***Fig. 2**. Research method process*

In detail, the independent variable was the "Break the Code" e-course, which was designed along the lines of the Problem-Based Learning (PBL) method. The dependent variables included student motivation and engagement.

Data was collected and analyzed using a mixed-methods approach to gain a clearer understanding of the impact of the PBL method. The results from the Motivated Strategies for Learning Questionnaire (MSLQ) were triangulated with other data sources, such as data from the Microsoft Teams report analytics feature and students' perceptions of their work through the lens of the PBL model, as recorded in the OneNote - Class Notebook application.

Research questions

This paper proposes the design, development, and implementation of an e-course on programming,

orchestrated along the lines of Problem-Based Learning (PBL) and delivered through the Microsoft Teams collaboration platform. In detail, the proposed instructional design approach describes how learning activities and learning environment (MS Teams) features are tailored to the five phases of the PBL teaching model. This is done by providing capabilities for the customization of an e-learning environment such as Microsoft Teams, while increasing its potential, to positively affect students' motivation and engagement. Under this main purpose, the research questions (R.Q.) are formed as follows:

To R.Q.1. To what extent does the e-course affect Students' motivation?

R.Q.2: What is the impact of the e-course design and implementation on students' engagement?

R.Q.3: What are the students' perceptions towards the PBL method and what learning outcomes do they believe they have attained?

Participants

The study sample consisted of 162 (97 females, 65 males; 59.1%, and 40.1% respectively) first-year undergraduate business administration students from the University of West Attica, who voluntarily enrolled in the e-course titled "Break the Code", as a part of "Introduction to Computer Science & Programming" academic course. The study population was selected to be first-year students instead of those in higher academic years. This decision was made because first-year students had recently entered tertiary education and had not yet developed established learning attitudes and behaviors. A characteristic that makes individuals more receptive to age-related changes [33]. Furthermore, the design and implementation of the e-course were carried out by a postgraduate student working on his master's thesis, under the guidance of two professors from the University of West Attica.

Data collection tools

Measuring motivation

To measure students' motivational orientations, we utilized a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ contains 81 items divided into two main sections: motivation (31 items) and learning strategies (50 items). The motivation section includes the following dimensions: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. The learning strategies section includes dimensions for rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time management, study environment, effort regulation, peer learning, and help-seeking [34]. The adapted version of MSLQ consisted only of the motivation section. Furthermore, the motivation section consisted of 21 items distributed into three dimensions: intrinsic goal orientation, extrinsic goal orientation, and self-efficacy for learning and performance. All the students were asked to answer the MSLQ before and after completing the e-course, "Break the Code." Responding was on a seven - point Likert Scale, ranging from "1 - Strongly Disagree" to "7 - Strongly Agree." As mentioned above, the students' perceptions of the PBL teaching and learning method, as recorded in the OneNote - Class Notebook application, were also analyzed to further support the results of the MSLQ questionnaire.

Measuring engagement

To measure students' engagement, we utilized the Microsoft Teams report analytics feature. This feature records the following data: the total number of publications, posts, replies, reactions, and active users. It is important to note that the term "active users" refers to the unique users who engage in any activity on Microsoft Teams during the specified date range for the user activity report.

Experimental e-course instructional design and learning procedure

This section presents a well-organized instructional design for learning based on the PBL method, as proposed by Arends [35]. This approach also refers to the customization of the Microsoft Teams platform, with a focus on incorporating embedded features as a crucial element of the design (**Table 1**).

Table 1*: Instructional design of the e-course "Break the Code".*

N.	PBL Phases	Strategies	Description of activities	Roles
1.	Orient students to the problem	Climate setting	1.1 Post a welcome message in the "Posts" Tab.	Educator
		Presentation	1.2 Present the problem and the mini syllabus.	Educator
		Think-vote-share	1.3 Ask recall questions using the "Voting" feature.	Educator
		Self-assessment (Pre-test)	1.4 Self-evaluation of students' motivation using MSLQ through the MS Forms application.	Students
2.	Organize students for study	Small group work	2.1 Create teams using the Microsoft Forms application.	Students
			2.2 Allocate roles using the Microsoft Forms application.	Teams
			2.3 Assign responsibilities (tasks per role) using the Microsoft Planner application.	Teams
3.	Assist independent and group	Guided research	3.1 Post supportive learning resources in the "Posts" Tab.	Educator
			3.2 Provide feedback through the "Posts" Tab.	Educator
			3.3 Study learning resources through the "Files" Tab.	Teams
			3.4 Update tasks progress using the Microsoft Planner application.	Teams
4.	Develop and present artifacts and exhibits	3-2-1 strategy	4.1 Search, evaluate, and document three resources in the "Collaboration Space" section of the OneNote application.	Analyst

			4.2 Post two questions in the "Posts" tab on the central channel of the e-course and respond to one inquiry from another team.	Analyst
		Small group work	4.3 Schedule team meetings using the" Calendar" feature.	Leader
			4.4 Develop a solution and conduct the initial code review (1st code revision).	Developers
		Collaborative coding	4.5 Conduct the second code review (2nd code revision) and submit the final deliverables through the "Assignments" Tab.	Leader
		Presentation	4.6 Present the proposed solution at a plenary session.	Leader
		Small group work	4.7 Update tasks progress using the Microsoft Planner application.	Teams
5.	Analyze and evaluate the problem-solving process	Self-assessment (Post-test)	5.1 Self-evaluation of students' motivation using MSLQ through the Microsoft Forms application	Students
		Group assessment	5.2 Group evaluation is conducted by team members collaboratively sharing their perspectives on working with the PBL method using OneNote application.	Teams
		Feedback	5.3 Post the completion certificates in the "Posts" Tab.	Educator

The entire educational intervention was structured according to the five phases of the PBL method. A detailed description of each phase of the instructional design is provided below:

In the initial stage of PBL method, students are presented with a problem that they are required to resolve. This problem involved developing a small-scale application to implement a specific encryption algorithm. Furthermore, the initial assessment of the students' motivation was conducted in this phase through the completion of the Motivate Strategies for Learning Questionnaire (MSLQ).

In the second phase of the PBL, teams were formed, each consisting of four individuals who were assigned specific roles and responsibilities. Specifically, the students were asked to choose among the roles of leader, analyst, and developer. So that each team will have one leader, one analyst, and two programmers.

In the third phase of the PBL, the analyst of each team searched for and posted three digital resources relevant to the problem to be solved. Furthermore, the analyst posted two questions and responded to one inquiry from another team. The publications were posted using the "Posts" tab on the central channel of the e-course, and respond to one inquiry from another team.

In the fourth phase of the PBL, the two developers in each team engaged in collaborative code writing with all the other team members. They also conducted the first code review on the initially configured code, while the team leaders conducted the second code review.

In the fifth phase of the PBL, team leaders presented their proposed solutions in a plenary session, while the other teams evaluated them through discussion. After the experimental intervention, the students' motivation was reassessed by having them complete the MSLQ self-report questionnaire. Finally, group evaluation is conducted by team members collaboratively sharing their perspectives on working with the PBL method. Specifically, group evaluation is conducted by writing a paragraph in the "Collaboration Space" section of the OneNote - Class Notebook application.

Roles and responsibilities

A significant number of studies and meta-analyses [36], [37] have documented that collaboration and internal competition within working groups lead to better learning outcomes compared to individual effort and interpersonal competition. Based on the proposed instructional design approach of the experimental e-course, students were divided into small groups of three to four individuals. This is because communication is easier in smaller groups, and it is generally easier to reach agreement compared to larger groups. Moreover, in larger groups, the challenge of finding a completely independent task often results in task overlap and eventually task merging [38]. To avoid the aforementioned dysfunction, students were assigned specific roles with predefined responsibilities. The selection of roles (leader, analyst, developer) was based on the demands in the job market within the business and programming sectors. It is noteworthy that the crucial role of the beta-tester was deliberately omitted, and its responsibilities were transferred to the entire team to enhance the sense of collective responsibility among its members. **Table 2** below presents the roles and their corresponding responsibilities.

Table 2*: Group roles aligned with specific responsibilities*

	Roles	Responsibilities
1.	Leader	• Plans and implements team meetings. • Conducts the final review of the solution (2nd code revision). • Submits the proposed solution.
2.	Analyst	• Searches, records, and evaluates three digital resources for the development of the solution. • Publishes two questions and responds to another team's inquiry.
3.	Developer	• Develops the solution in collaboration with other team members. • Conducts the initial review of the group's solution (1st code revision).

Customization of MS Teams

Two types of teams were created to meet the requirements of the proposed design for learning. The central e-class team, as well as separate teams were formed for each of the 51 working groups. The main team was created using the default template for class creation in Microsoft Teams. The class template (**Fig. 3**) includes the following tabs by default: "Posts", "Files", "Class Notebook",

"Assignments", and "Grades." Additionally, two more tabs were added: the "Team Declaration" tab for team selection and the "Self-Assessment Survey" tab for distributing the Motivation Strategies for Learning Questionnaire (MSLQ).

Fig. 3*. E-course's central channel tabs*

In detail, within the "Posts" tab, students had access to educator's announcements (**Fig. 4**). In the "Files" tab, students had access to the learning resources of the e-course, including the video recordings of the e-class sessions.

Fig. 4*. Announcement in the "Posts" tab on MS Teams platform*

In the "Class Notebook" tab, students utilized the OneNote application, which is seamlessly integrated into the Microsoft Teams platform, to compile a comprehensive list of supplementary learning resources (**Fig. 5**). Furthermore, by navigating between the "Class Notebook" sections, they also had access to the resources of other teams. Additionally, in the "Class Notebook" tab, each team wrote a paragraph describing their experience working with the Problem-Based Learning method. In the "Team Declaration" tab, students declared the composition of their team by completing the corresponding form using the Microsoft Forms application, which is integrated into the Microsoft Teams platform. The "Assignments" and "Grades" tabs are used for uploading assignments and evaluating submissions (deliverables).

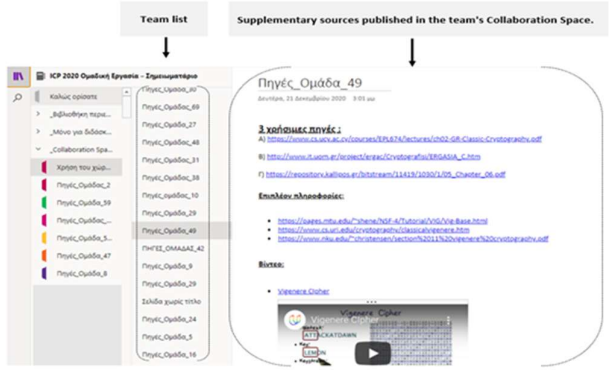

Fig. 5. *"Collaboration Space" section in the "Class Notebook" tab on the MS Teams platform.*

As mentioned above, a separate team was created for each group of students, with the following tabs: "Posts", "Files", "Plan", and "Meeting Notes". In the "Posts" tab, students communicated by exchanging written messages and files. In the "Files" tab, students had access to learning resources and the ability to upload and exchange their work. In the "Plan" tab, students recorded their individual progress on tasks based on their roles using the user interface of the Microsoft Planner application, which is integrated into the Microsoft Teams platform. Additionally, it should be noted that in the user interface of the Microsoft Planner application, tasks for each role had different colors (red, yellow, blue), corresponding to the three different roles (leader, analyst, developer) (**Fig. 6**).

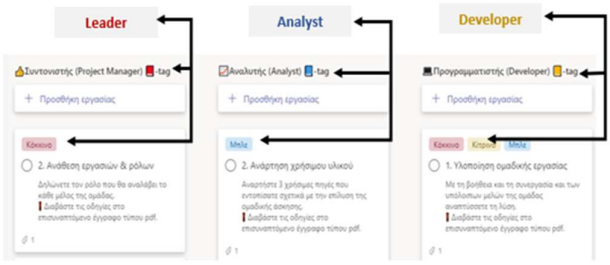

Fig. 6*. Task assignment in Microsoft Planner's user interface.*

This color-coding system made it easy to identify tasks assigned to each role. Finally, in the "Meeting Notes" tab, students could take notes during their team meetings.

IV. RESULTS

To measure students' motivational orientations, we utilized a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ). The internal consistency of the pretest and posttest questionnaires was assessed by calculating Cronbach's alpha coefficients. Reliability analysis showed that all three sub-scales (intrinsic goal orientation, extrinsic goal orientation, and self-efficacy for learning and performance) had acceptable levels of internal consistency, with Cronbach's alpha values ranging from 0.72 to 0.94. These values are within the expected range reported in the MSLQ manual by Pintrich et al. [39]. The statistical analysis, we conducted through the IBM SPSS statistical software in version 23 and the significance level was set to 0.05.

Evaluating students' motivational orientations

In this study, the Wilcoxon signed rank test was conducted to assess the effects of the "Break the Code" e-course, which was designed along the lines of the Problem-Based Learning (PBL) method, on students' motivational orientations. The Wilcoxon Sign Rank Test was preferred, due to a non-normal distribution (Shapiro-Wilk test, $p < .05$) in all three motivation factors: intrinsic goal orientation, extrinsic goal orientation, and self-efficacy. The effect size (r) for the Wilcoxon signed rank test was also calculated by using the formula: $r=z/\sqrt{N}$ (r: effect size; z: z value; N: total number of pairs). **Table 3** displays the descriptive statistics for the motivational orientations before and after the e-course, as well as the results of the Wilcoxon signed rank test.

Table 3*: Wilcoxon sign rank test results of students' motivational orientations before and after the experimental intervention.*

	Pretest	Posttest

Subscales	Mean	Std.	Mean	Std.	Z	p
Intrinsic goal orientation	5.73	.68	5.97	.73	-3.73[a]	< .001*
Extrinsic goal orientation	5.37	1.12	5.37	1.11	-.53[a]	.595
Self-efficacy	5.03	1.08	5.42	.97	-5.58[a]	< .001*

Note: *p <.05

Given the above results, we can conclude that only the intrinsic goal orientation and self-efficacy subscales of MSLQ were significantly affected by the e-course. Further details for each of the students' motivational orientations are provided below.

Intrinsic goal orientation

The results revealed that intrinsic goal orientation scores were significantly higher after the intervention (Mdn=6.00, n=162) compared to before (Mdn=5.75, n=162), z=-3.73, p=.00 with a small effect size, r=.29. However, the small effect size of the differences between the students' scores on the intrinsic goal orientation scale in the pre- and post-tests indicates that the suggested instructional approach may have the potential to foster their intrinsic motivation.

Extrinsic goal orientation

The results revealed no significant difference in student extrinsic goal orientation scores before (Mdn = 5.50, n=162) and after (Mdn = 5.50, n=162) the intervention, z =-0.53, p =.59 with a small effect size <.01.

Self-efficacy for learning and performance

The results revealed that self-efficacy for learning and performance score were higher after the intervention (Mdn=5.63,n=162) compared to before (Mdn=5.13, n=162), z=-5.58, p=.00 with a medium effect size, r= .31.

Evaluating students' engagement

The engagement of students was assessed using the cross-team analytics report feature provided by the Microsoft Teams platform. This feature records the total number of posts, replies, and reactions, as well as the total number of active users. It also includes a trend line that shows the team activity during the specified time period. **Fig. 7** displays a significant increase in the total number of posts, replies, and reactions after the e-course completion.

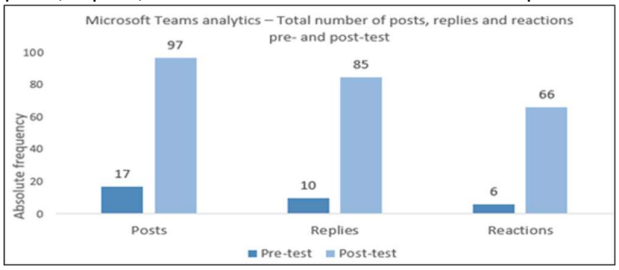

Fig. 7. *Comparison of the total number of posts, replies, and reactions before and after the experimental intervention.*

Moreover, after completing the "Break the Code" e-course, there was a noticeable increase in the total number of active users per day during the specified period. **Fig. 8** above illustrates the effectiveness of the intervention in promoting students' participation.

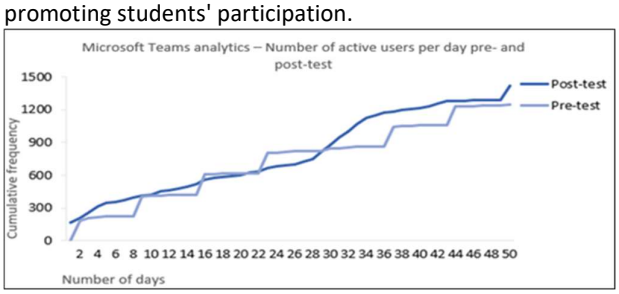

Fig. 8. *Comparison of the total number of active users over time before and after the experimental intervention*

Overall, considering the increase in the number of posts, replies, and announcements, as well as the increase in the total number of active users, the intervention had a positive impact on students' engagement.

Evaluating students' perceptions towards the Problem-Based Learning method

Students' perceptions towards the Problem-Based Learning method were assessed through an open-ended question. They were asked to collectively describe their personal experiences of working with the PBL method after completing the e-course. This open-ended question was also used to enhance the results of the MSLQ questionnaire.

The exploration of students' answers is conducted using the inductive technique of content analysis. Specifically, the researchers use participants' own words to code their responses, ensuring a precise interpretation. This method is commonly used to analyze students' perceptions of their motivation and learning strategies in a specific learning task. Moreover, the transcripts were independently analyzed by the researcher and a doctoral student. Initially, each reader reviewed the transcripts to identify common themes in the participants' responses. They then met multiple times to discuss, compare, and refine these themes until they reached a consensus. This process resulted in the three distinct themes, which are presented below (**Table 4**).

Table 4*: Coding categories for students' perceptions towards the PBL method.*

Category	Brief description	Exemplary statement
1.Knowledge	1.1 Development of an encryption-decryption program	We [acquired new knowledge] regarding [encryption] and [decryption] throughout this project.
2.Skills	2.1 Collaboration and teamwork	We developed [skills in collaborating] with new individuals.
	2.2 Communication	We had the opportunity to [get to know each other] and [establish communication].

	and exchange of ideas	
	2.3 Role distribution and assignment of responsibilities	Everyone [fulfilled their respective role], resulting in the [efficient completion of the project] without any tension.
	2.4 Information search and evaluation	We acquired the [skill of searching] for online resources and [identifying the most reliable] and relevant [information] that helped us accomplish our project.
	2.5 Use of the Microsoft Teams platform	We learned many new things, and one of them was the [familiarization] of all team members [with the Microsoft Teams platform].
3.Attitudes	3.1 Intrinsic goal orientation	This project allowed us to [engage] with a [very interesting] topic.
	3.2 Extrinsic goal orientation	By completing this group project, we are getting closer to achieving our main goal of [performing well] on the [final exams].
	3.3 Self efficacy for learning and performance	Despite the difficulties we faced while working on a demanding program, we[managed to successfully complete it], and we are [extremely pleased with the outcome].

Knowledge

This theme includes responses noting that in the context of the PBL method, learners had the opportunity to enhance their knowledge regarding the development of encryption and decryption applications. For example, one team noted that: we had the opportunity to [delve deeper into encryption] and [expand our knowledge].

Skills

This theme includes references noting the development of soft skills through the PBL method. For example, one team noted that: we developed [skills in collaborating] with new individuals. Another team mentioned that: we had the opportunity to get to know each other and [establish an effective communication]. Also, the role distribution was highlighted by a team that noted: each team member [took on their own responsibilities]. Moreover, a team pointed out that: [finding credible sources] for the project helped us [successfully complete it]. Many of the teams also emphasized the utilization of the Microsoft Teams platform. For example, one team noted that: we had the opportunity to [familiarize ourselves with the application of Microsoft Teams].

Attitudes

This theme refers to the students' motivational orientations. Most of the teams referred to the intrinsic goal orientation. For example, a team stated that: this project allowed us to [engage] with a [very interesting] topic. Another team highlighted the role of extrinsic goal orientation, noting that: completing this group project brings us closer to achieving our [main goal of performing well on the final exams]. Furthermore, another team highlighted the importance of self-efficacy for learning and performance. As they reported: there was excellent teamwork, flawless communication to [achieve the desired result], and [great consistency] in our scheduled meetings to [achieve the desirable outcome].

V. DISCUSSION

The results presented in the previous section can be further discussed in terms of the three research questions. To what extent is the design and implementation of the "Break the Code" e-course aligned with the Problem-Based Learning (PBL) method and delivered through the MS Teams affects?

R.Q.1.Students' motivation

This study examined the impact of the "Break the Code" e-course on students' motivation and engagement. It also explored students' perceptions towards the PBL method. The findings indicated that the proposed instructional design approach, based on the PBL method, had a positive effect on students' intrinsic motivation, self-efficacy, and no impact on students' extrinsic motivation. This pattern of findings is consistent with that already reported in the literature [40], [41], [42]. The increase in students' intrinsic goal orientation could indicate that students enrolled in the PBL e-course because they were genuinely interested in it. Moreover, the increase in students' intrinsic goal orientation was also documented through the process of data triangulation, using both quantitative data obtained from the MSLQ questionnaire and the results of the content analysis of the students' answers to the related open-ended question. For example, as reflected in the words of a team: the research and the project were [quite interesting] for all of us. On the other hand, no statistically significant differences were recorded in the students' extrinsic goal orientation, indicating that first-year students, at the beginning of their academic studies, are not affected by external rewards or grades. The above result is consistent with the fact that only one out of the 51 teams reported that: by completing this group project, we are getting closer to achieving our main goal of [performing well] on the [final exams]. Another crucial research finding is that the featured instructional approach enhanced students' self-efficacy, as they gained confidence in their ability to solve problems and succeed in their group project. The increase in students' self-efficacy, as recorded from the statistical analysis of the MSLQ data, is consistent with the findings from the content analysis of students' perceptions towards the PBL method. For example, one team mentioned: despite the difficulties we faced while working on a demanding program, we [managed to successfully complete it], and we are [extremely pleased with the outcome].

R.Q.2.Students' engagement

According to the analytics data from Microsoft Teams platform, there was an increase in students' engagement

before and after the experimental e-course. These research findings align with previous studies in the field of academic education, which have documented an increase in students' engagement after implementing the PBL method [43], [44]. Moreover, the increase in students' engagement was also documented in their perceptions of the PBL method. For instance, one team mentioned, we [gained interest] in something previously unfamiliar to us, such as cryptography. Another added: the topic of cryptography and decryption [fascinated us from every perspective]. Moreover, the recorded increase in the number of active users before and after the experimental intervention can be attributed to students actively engaging in learning processes and projects, especially when they find the subject matter interesting.

R.Q.3. What are the students' perceptions towards the PBL method and the learning outcomes they felt they obtained?

The proposed design for learning based on the PBL method had a positive impact on engaging students in finding solutions to real life work-based situations. These findings agreed with works done by Gijbels et al. [45] and Nerali et al. [46], where learning in PBL format promotes teamwork, collaboration and improves the communication and the interaction among the group members. Furthermore, other learning outcomes of the PBL method, such as the development of critical information retrieval skills and a deeper understanding of knowledge, are often cited as some of the main benefits of this approach [47], [48].

VI. Conclusions

In light of the COVID-19 pandemic, educational institutions have increasingly adopted online learning across all levels of education. Consequently, educators are faced with the challenge of effectively utilizing the existing teaching methods in both synchronous and asynchronous learning environments to facilitate learning for students. However, when using video conferencing tools and learning management systems to support the whole learning process, learners usually lack motivation as the use of technology alone is a significant source of distraction. The purpose of the presented instructional design approach developed by this study in the context of "Break the Code" e-course, is to promote students' motivation and enhance participation. Based on the results from the MSLQ survey, which were triangulated with the data from the MS Teams platform and the students' perceptions toward the PBL method, this study confirms that the featured instructional approach, tailored along the lines of the PBL method, effectively fosters student motivation and engagement. Furthermore, considering the students' perceptions of their work through the lens of the PBL method, the proposed instructional design for learning is not only effective in promoting learners' motivation and engagement but also in promoting learners' deeper understanding of knowledge and fostering crucial soft work-based skills such as collaboration and communication. However, since the current research design lacks a control group, the repetition of the research with a larger sample and the inclusion of a control group are recommended to enhance the validity of the research findings.

VII. References

[1] A. A. Balkhair, 'COVID-19 Pandemic: A New Chapter in the History of Infectious Diseases', *Oman Med J*, vol. 35, no. 2, p. e123, Apr. 2020, doi: 10.5001/omj.2020.41.

[2] A. E. Widjaja, J. V. Chen, and T. M. Hiele, 'The Effect of Online Participation in Online Learning Course for Studying Trust in Information and Communication Technologies':, *International Journal of Cyber Behavior, Psychology and Learning*, vol. 6, no. 3, pp. 79–93, Jul. 2016, doi: 10.4018/IJCBPL.2016070106.

[3] D. U. Bolliger, S. Supanakorn, and C. Boggs, 'Impact of podcasting on student motivation in the online learning environment', *Computers & Education*, vol. 55, no. 2, pp. 714–722, Sep. 2010, doi: 10.1016/j.compedu.2010.03.004.

[4] I. Yukiko, *Online Education for Lifelong Learning*. Idea Group Inc (IGI), 2007.

[5] P. g. de Barba, G. e. Kennedy, and M. d. Ainley, 'The role of students' motivation and participation in predicting performance in a MOOC', *Journal of Computer Assisted Learning*, vol. 32, no. 3, pp. 218–231, 2016, doi: 10.1111/jcal.12130.

[6] J. Dewey, 'Essays in experimental logic', *The University of Chicago Press*, 1916, doi: https://doi.org/10.1037/13833-000.

[7] J. Dewey, *Essays in Experimental Logic*. SIU Press, 2007.

[8] H. S. Barrows, 'A taxonomy of problem-based learning methods', *Medical Education*, vol. 20, no. 6, pp. 481–486, 1986, doi: 10.1111/j.1365-2923.1986.tb01386.x.

[9] C. E. Hmelo-Silver, 'Problem-Based Learning: What and How Do Students Learn?', *Educational Psychology Review*, vol. 16, no. 3, pp. 235–266, Sep. 2004, doi: 10.1023/B:EDPR.0000034022.16470.f3.

[10] L. Wijnia, S. M. M. Loyens, and E. Derous, 'Investigating effects of problem-based versus lecture-based learning environments on student motivation', *Contemporary Educational Psychology*, vol. 36, no. 2, pp. 101–113, Apr. 2011, doi: 10.1016/j.cedpsych.2010.11.003.

[11] S. Pedersen, 'Motivational Orientation in a Problem-Based Learning Environment', *Journal of Interactive Learning Research*, vol. 14, no. 1, pp. 51–77, 2003.

[12] L. Martin, J. West, and K. Bill, 'Incorporating Problem-Based Learning Strategies to Develop Learner Autonomy and Employability Skills in Sports Science Undergraduates', *Journal of Hospitality, Leisure, Sport & Tourism Education.*, vol. 7, no. 1, Art. no. 1, 2008, doi: 10.3794/johlste.71.169.

[13] K. Bourdas, A. Melissourgos, and F. Paraskeva, 'Users' Experience in a Gamified Online Educational Environment'.

[14] E. Y. Chung, 'Facilitating learning of community-based rehabilitation through problem-based learning in higher education', *BMC Medical Education*, vol. 19, no. 1, p. 433, Nov. 2019, doi: 10.1186/s12909-019-1868-4.

[15] D. R. Woods, *Problem-based Learning: How to Gain the Most from PBL*. Donald R. Woods, 1994.

[16] S. Bridges, C. McGrath, and T. L. Whitehill, Eds., *Problem-Based Learning in Clinical Education: The Next Generation*. Dordrecht: Springer Netherlands, 2012. doi: 10.1007/978-94-007-2515-7.

[17] A. Alrahlah, 'How effective the problem-based learning (PBL) in dental education. A critical review', *The Saudi Dental Journal*, vol. 28, no. 4, pp. 155–161, Oct. 2016, doi: 10.1016/j.sdentj.2016.08.003.

[18] B. Weiner, 'History of Motivational Research in Education', *Journal of Educational Psychology*, vol. 82, pp. 616–622, Dec. 1990, doi: 10.1037/0022-0663.82.4.616.

[19] N. Sirhan, G. Heileman, and C. Lamb, 'Traffic Offloading Impact on the Performance of Channel-Aware/Qos-Aware Scheduling Algorithms for Video-Applications Over Lte-A Hetnets Using Carrier Aggregation', *International journal of Computer Networks & Communications*, vol. 7, pp. 75–90, May 2015, doi: 10.5121/ijcnc.2015.7306.

[20] S. O. Akinoso, 'Motivation and ICT in Secondary School Mathematics using Unified Theory of Acceptance and Use of Technology Model', *Indonesian J. Educ. Res. Technol.*, vol. 3, no. 1, pp. 79–90, Feb. 2022, doi: 10.17509/ijert.v3i1.47183.

[21] S. Bishara, 'Humor, motivation and achievements in mathematics in students with learning disabilities', *Cogent Education*, vol. 10, no. 1, p. 2162694, Dec. 2023, doi: 10.1080/2331186X.2022.2162694.

[22] E. L. Deci and R. M. Ryan, 'The general causality orientations scale: Self-determination in personality', *Journal of Research in Personality*, vol. 19, no. 2, pp. 109–134, Jun. 1985, doi: 10.1016/0092-6566(85)90023-6.

[23] A. Kapsalis, *Educational Psychology*, VI. Thessaloniki: Kyriakides Bros. – Publications S.A., 2019. Available in Gereek

[24] P. R. Pintrich, 'Multiple Goals, Multiple Pathways: The Role of Goal Orientation in Learning and Achievement'.

[25] S. Rach, 'Motivational states in an undergraduate mathematics course: relations between facets of individual interest, task values, basic needs, and effort', *ZDM Mathematics Education*, vol. 55, no. 2, pp. 461–476, Mar. 2023, doi: 10.1007/s11858-022-01406-x.

[26] R. E. Slavin, 'Educational Psychology: Theory and Practice, Tenth Edition'.

[27] A. Bandura, 'Self-efficacy: Toward a unifying theory of behavioral change', *Psychological Review*, vol. 84, no. 2, pp. 191–215, 1977, doi: 10.1037/0033-295X.84.2.191.

[28] M. Bong, 'Role of Self-Efficacy and Task-Value in Predicting College Students' Course Performance and Future Enrollment Intentions', *Contemporary Educational Psychology*, vol. 26, no. 4, pp. 553–570, Oct. 2001, doi: 10.1006/ceps.2000.1048.

[29] L. Rababah, 'Jadara University Students'Attitudes towards the Use of Microsoft Teams in Learning English as a Foreign Language', vol. 4, pp. 59–64, Sep. 2020, doi: 10.22158/sll.v4n4p59.

[30] J. @ E. Luaran, N. N. Samsuri, F. A. Nadzri, and K. B. M. Rom, 'A Study on the Student's Perspective on the Effectiveness of Using e-learning', *Procedia - Social and Behavioral Sciences*, vol. 123, pp. 139–144, Mar. 2014, doi: 10.1016/j.sbspro.2014.01.1407.

[31] T. D. Cook, *Qualitative and Quantitative Methods in Evaluation*. Beverly Hills, CA: Sage Publications, 1979.

[32] L. Cohen, *Research Methods in Education*. 2018.

[33] J. Nisbet and J. Shucksmith, *Learning Strategies*. London: Routledge, 2017. doi: 10.4324/9781315188652.

[34] P. R. Pintrich and A. Others, 'A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)', 1991. Accessed: Aug. 04, 2025. [Online]. Available: https://eric.ed.gov/?id=ED338122

[35] R. Arends, *Learning to Teach*, 10th ed. McGraw-Hill, 2012.

[36] D. Johnson, G. Maruyama, R. Johnson, D. Nelson, and L. Skon, 'Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis', *Psychological Bulletin*, vol. 89, pp. 47–62, Jan. 1981, doi: 10.1037/0033-2909.89.1.47.

[37] D. W. Johnson and R. T. Johnson, *Cooperation and competition: Theory and research*. in Cooperation and competition: Theory and research. Edina, MN, US: Interaction Book Company, 1989, pp. viii, 253.

[38] G. Hedin, L. Bendix, and B. Magnusson, 'Teaching Software Development Using Extreme Programming', in *Reflections on the Teaching of Programming: Methods and Implementations*, J. Bennedsen, M. E. Caspersen, and M. Kölling, Eds., Berlin, Heidelberg: Springer, 2008, pp. 166–189. doi: 10.1007/978-3-540-77934-6_14.

[39] P. R. Pintrich, D. A. F. Smith, T. Garcia, and W. J. Mckeachie, 'Reliability and Predictive Validity of the Motivated Strategies for Learning Questionnaire (Mslq)', *Educational and Psychological Measurement*, vol. 53, no. 3, pp. 801–813, Sep. 1993, doi: 10.1177/0013164493053003024.

[40] N. Massa, M. Dischino, J. Donnelly, and F. Hanes, 'Problem-based learning in photonics technology education: Assessing student learning', 2009.

[41] F. Paraskeva, A. Alexiou, H. Bouta, S. Mysirlaki, D. J. Sotiropoulos, and A.-M. Souki, 'Motivating Engineer Students in E-learning Courses with Problem Based Learning and Self-Regulated Learning on the apT2CLE4"Research Methods" Environment', in *Learning Technology for Education Challenges*, L. Uden, D. Liberona, G. Sanchez, and S. Rodríguez-González, Eds., Cham: Springer International Publishing, 2019, pp. 189–201. doi: 10.1007/978-3-030-20798-4_17.

[42] S. Sungur and C. Tekkaya, 'Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning', *The Journal of Educational Research*, vol. 99, no. 5, pp. 307–320, May 2006, doi: 10.3200/JOER.99.5.307-320.

[43] C. Foo, B. Cheung, and K. Chu, 'A comparative study regarding distance learning and the conventional face-to-face approach conducted problem-based learning tutorial during the COVID-19 pandemic', *BMC Med Educ*, vol. 21, no. 1, p. 141, Mar. 2021, doi: 10.1186/s12909-021-02575-1.

[44] E. Unal and H. Cakir, 'The effect of technology-supported collaborative problem solving method on students' achievement and engagement', *Educ Inf Technol*, vol. 26, no. 4, pp. 4127–4150, Jul. 2021, doi: 10.1007/s10639-021-10463-w.

[45] D. Gijbels, F. Dochy, P. Van den Bossche, and M. Segers, 'Effects of Problem-Based Learning: A Meta-Analysis From the Angle of Assessment', *Review of Educational Research*, vol. 75, no. 1, pp. 27–61, Mar. 2005, doi: 10.3102/00346543075001027.

[46] J. T. Nerali, L. A. Telang, A. Telang, and P. V. K. Chakravarthy, 'Problem-based learning in dentistry, implementation, and student perceptions', *Saudi Journal of Oral Sciences*, vol. 7, no. 3, p. 194, Dec. 2020, doi: 10.4103/sjos.SJOralSci_15_20.

[47] M. L. Moliner *et al.*, 'Acquisition of transversal skills through PBL: a study of the perceptions of the students and teachers in materials science courses in engineering', *Multidisciplinary Journal for Education, Social and Technological Sciences*, vol. 2, no. 2, Art. no. 2, Sep. 2015, doi: 10.4995/muse.2015.3896.

[48] F. Sulaiman, 'Students' Perceptions of Implementing Problem-Based Learning in a Physics Course', *Procedia - Social and Behavioral Sciences*, vol. 7, pp. 355–362, Jan. 2010, doi: 10.1016/j.sbspro.2010.10.048.

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