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The Theoretical and Practical Aspects of Archival Document Restoration and Conservation

Abstract

This article explores the theoretical and practical aspects of archival document restoration and conservation processes. The preservation of historical documents and the protection of their physical condition are among the main directions of archival management. The study analyzes the causes of document damage, restoration methods, and the role of modern technologies. The effectiveness of conservation and restoration methods, as well as their application in the long-term perspective, are discussed. The findings provide theoretical and practical recommendations for the application of new approaches in the preservation of archival documents.

Keywords*: Archival Documents, Conservation, Restoration, Document Preservation, Paper Material Restoration, Information Security*

Arşiv Belgelerinin Restorasyonu ve Konservasyonunun Teorik ve Pratik Yönleri

Öz

Bu makale, arşiv belgelerinin restorasyon ve konservasyon süreçlerinin teorik ve pratik yönlerini incelemektedir. Tarihi belgelerin muhafazası ve fiziksel durumlarının korunması, arşiv yönetiminin ana yönleri arasındadır. Çalışma, belge hasarının nedenlerini, restorasyon yöntemlerini ve modern teknolojilerin rolünü analiz etmektedir. Koruma ve restorasyon yöntemlerinin etkinliği ve bunların uzun

vadeli perspektifte uygulanması tartışılmaktadır. Bulgular, arşiv belgelerinin korunmasında yeni yaklaşımların uygulanması için teorik ve pratik öneriler sunmaktadır.

Anahtar Kelimeler: *Arşiv Belgeleri, Konservasyon, Restorasyon, Belge Koruma, Kağıt Malzeme Restorasyonu, Bilgi Güvenliği*

Introduction

The restoration and conservation of archival documents are of significant importance in ensuring the continuity of information resources. The protection of documents from physical and chemical influences, as well as the application of modern methods and technologies to extend their longevity, is the main issue of this research. The study analyzes international practices and the state of local archives, identifying the problems in this field.

*Methodology:

-Qualitative and quantitative research methods;

-Expert evaluation of document condition;

-Interviews with archival specialists;

-Application of modern restoration and conservation technologies;

-Analysis and comparison of scientific literature.

*Solution to the Problem:

-Identification of degradation processes of documents;

-Classification of restoration and conservation methods;

-Application of new technologies for the preservation of paper, parchment, and other materials;

-Analysis of digitization and preventive conservation measures;

-Recommendations based on international practices.

*Results

The research focuses on identifying the most effective methods for the preservation and restoration of archival documents. The importance of applying modern technologies in the field of conservation and restoration is emphasized. Based on the research, practical recommendations are made for ensuring document security.

*Identification of document degradation processes. The degradation of archival documents is characterized by the gradual change in their physical and chemical properties over time, leading to their eventual deterioration. Early identification of degradation processes and preventing them is essential to ensuring the longevity of documents.

1. Types and causes of degradation

1.1. Physical Degradation:

**Mechanical impacts:* Frequent use of documents, tearing, folding, or crumpling of pages;

**Humidity and temperature changes:* These factors cause warping, shrinking, and brittleness;

**Pests:* The effects of biological agents such as silverfish, termites, and rodents.

1.2. Chemical degradation

**Acidification:* The oxidation and breakdown of cellulose in low-quality paper materials;

**Light and UV radiation:* Paper discoloration, fading of ink, and wear of printed materials (Rzayeva, 2024).

**Air pollution:* Reactions between sulfur dioxide (SO_2) and nitrogen oxides (NOx) gases with paper and ink.

2. Identification of Degradation Processes

Various analytical methods are applied to detect degradation processes in documents:

Visual inspection: Physical examination of the document for cracks, stains, and color changes;

Microscopic analysis: Examination of changes in the structure of paper fibers;

Chemical tests: Measurement of pH levels, acid and oxidation levels;

Spectroscopic analyses: Use of UV-Vis, FTIR, and Raman spectroscopy to analyze the chemical composition of ink and paper.

Thermogravimetric analysis (TGA): Used to test the document's resistance to heat.

3. Preventive Measures and Protection Strategies

To prevent degradation, the following measures should be implemented:

**Climate control*: Temperature (18-22°C) and relative humidity (45-55%) should be kept stable;

**Proper storage environment*: Documents should be stored in acid-free folders and special conservation materials;

**Biological threat management*: Use of pesticides and biological control methods to prevent pests.

These analyses and measures can help in identifying document degradation in time and implementing effective protection strategies.

Classification of restoration and conservation methods. Various restoration and conservation methods are applied to ensure the longevity of archival documents. These methods aim to prevent physical, chemical, and biological degradation and ensure the protection of the documents.

4. Difference between conservation and restoration:

**Conservation*: Preventive measures applied to preserve the current condition of documents and prevent further damage;

***Restoration*: The process of returning severely damaged and degraded documents to their original state through physical and chemical methods.

5. Conservation methods (Preventive measures):

Conservation includes non-invasive or minimally invasive methods aimed at the long-term protection of documents.

5.1. Physical conservation

**Climate control*: Temperature (18-22°C) and relative humidity (45-55%) should be maintained;

***Proper storage conditions:* Archival documents should be stored in acid-free folders, special archival boxes, and dark environments;

**UV and light control*: Light-sensitive materials should be stored under protective coverings;

**Prevention of dust and contamination*: Regular cleaning should be carried out in storage areas.

5.2. Biological Conservation

**Pest control*: Pesticides and biological control measures are applied to protect documents from silverfish, termites, and mold fungi;

**Sterilization*: Biologically contaminated documents are sterilized in controlled environments.

5.3. Chemical conservation

***Deacidification*: Chemical substances (e.g., calcium hydroxide solution) are used to neutralize the high acidity in paper materials (Nadir & Sevda, 2022);

***Stabilization*: Chemical reagents are used to prevent oxidation of paper and ink.

5.4. Digital conservation

**Digitization*: Archival documents are scanned and stored electronically.

**Optical and infrared scanning for document restoration:* Restoration of invisible text and images using optical and infrared scanning technologies.

6. Restoration methods (reconstructive measures):

Restoration methods are focused on restoring the physical structure of documents.

6.1. Physical Restoration

**Mechanical cleaning*: Dust, dirt, and mold residues are removed using soft brushes and special vacuum devices;

**Flattening*: Crumpled or folded documents are straightened in a humidified environment;

Mending and reinforcing: Torn or broken pieces of paper are repaired using archival-quality adhesives and special paper materials.

6.2. Chemical restoration

Deacidification treatment: Special chemical agents (calcium hydroxide or magnesium bicarbonate) are used to reduce the acid level in the document;

Chemical bleaching: Yellowed or stained documents are restored with specific reagents (used in limited cases).

6.3. Biological restoration

Sterilization and antifungal treatment: Documents are sterilized using ethylene oxide or ultraviolet (UV) rays to prevent fungal and mold infections (Oqlu, 2021)

6.4. Digital restoration

Digital adjustment of scanned documents: Photoshop and AI-based programs are used to enhance the readability of faded or damaged texts;

Optical Character Recognition (OCR): Faded or corrupted text is digitally restored using OCR technology.

7. Modern technologies and innovative approaches

Nanotechnology: Nano-cellulose-based protective coatings are applied to prevent document degradation.

Plasma technology: Provides sterilization and protection of documents without altering the chemical or physical properties of paper.

3D reconstruction: Old and damaged documents are modeled in 3D and restored in virtual environments.

Application of new technologies for the preservation of paper, parchment, and other materials. The preservation of archival documents has become more efficient with the

development of modern technologies. Depending on the material's composition and structure, specific protection and restoration technologies are applied. This section analyzes new technologies used for the preservation of paper, parchment, and other archival materials (Nadir & Oruj, 2022).

8. New technologies for the preservation of paper materials

Paper-based documents are among the most vulnerable materials to biological and chemical degradation. To protect them, the following modern technologies are applied:

8.1. Application of nanotechnology

- *Deacidification via nanoparticles:* Nano-calcium carbonate and nano-magnesium oxide particles are used to neutralize the acidity of paper;
- *Nanotechnology-based Protective Coatings:* Ultra-thin, invisible protective layers are applied to paper to shield it from moisture and contamination.

8.2. Plasma technology

- *Cold plasma treatment:* Oxygen and nitrogen plasma are used to eliminate biological contamination and increase the durability of paper;
- *Plasma-Based Deacidification:* Considered a more environmentally friendly and safer alternative compared to chemical treatments.

8.3. Digitization and optical technologies

- *Multispectral and hyperspectral imaging:* These technologies help detect invisible and faded text and assist in the restoration of documents;
- *Optical character recognition (OCR) and AI-Based restoration:* Digital *versions of manuscripts are created, and texts are automatically recognized.*

9. New technologies for Preservation of parchment materials

Since parchment is made from animal skin, its preservation requires a different approach. Due to its sensitivity to humidity and temperature changes, modern technologies are used to ensure its protection.

9.1. Collagen stabilization technologies

- *Enzyme-Based Methods for Restoring Damaged Parchment:* Biological enzymes are used to clean contaminated and torn parchments.
- *Strengthening Collagen with Nanoparticles:* Collagen fibers in parchment are reinforced with nano-calcium particles to enhance their strength.

9.2. New tchnologies for humidity and temperature control

- *Sensor Systems for climate control:* IoT-based sensors continuously monitor temperature and humidity levels in environments where parchment is stored;
- *Infrared and ultraviolet analysis:* These methods are used to assess the level of damage to parchment.

These advanced methods and technologies help ensure the long-term preservation of archival documents, providing valuable resources for future generations. By applying innovative techniques like nanotechnology, plasma treatment, and digital restoration, archives can safeguard their collections while also making them accessible for research and education (Kazimi, Ismaylov & Rzayeva, 2023).

9.3. Digital conservation technologies

**3D Scanning and modeling:* Precise digital models of parchment documents are created and used in the restoration process;

**DNA Analysis for Document Origin Identification:* This method is used to determine which animal skin the parchment was made from and its age.

10. Innovative approaches for the preservation of other materials

In archives, materials such as papyrus, fabric, wax tablets, and magnetic tapes are also stored. The following new technologies are applied for their preservation:

10.1. New methods for preserving papyrus documents

**Microbiological analysis and enzyme-based conservation:* Used for detecting and neutralizing mold and bacteria;

**Optical scanners and multispectral imaging:* Applied to detect erased or invisible text on papyrus.

10.2. Fabric and textile document preservation

**Plasma-based disinfection:* A chemical-free method used for eliminating microorganisms.

10.3. Preservation of magnetic tapes and audiovisual documents

**Infrared laser-based data recovery:* Used to extract data from damaged magnetic tapes;

**AI-based automatic restoration*: Improves the quality of old video and audio recordings.

11. Prospective technologies and future trends

**AI and machine learning-based conservation:* Automatic analysis of archival documents and the determination of preservation strategies.

**Blockchain-based document authentication:* The application of blockchain technology to protect the authenticity of historical documents.

**Bioengineering-based creation of paper materials:* Development of longer-lasting and more environmentally sustainable document materials.

**Digitalization and preventive conservation measures analysis*

Digitalization and preventive conservation are considered key approaches for the long-term preservation of archival documents. Digitalization involves creating electronic versions of physical documents to ensure their preservation and accessibility, while preventive conservation includes necessary measures to maintain the physical condition of the documents.

12. The Essence and importance of digitalization

Digitalization is the process of transferring archival documents into electronic formats and storing digital copies. This method prevents physical wear and makes documents more accessible to a wider audience.

12.1. Benefits of digitalization

**Prevents physical wear:* Reduces the need for frequent handling of documents;

**Increases accessibility:* Electronic archives allow for global search and viewing capabilities;

**Data security and redundancy:* Digital formats reduce the risk of document loss, and multiple copies can be created;

**OCR and AI-Based Indexing:* Text recognition systems can automatically categorize documents and simplify searches.

12.2. Digitalization methods and technologies

**Scanning methods:* Flatbed scanners, document scanners, high-quality photographic methods;

**Multispectral and hyperspectral imaging:* Used to detect invisible text and improve readability of historical documents;

**3D Scanning and virtual reconstruction:* Models documents that are bent, damaged, or unreadable;

**Blockchain technology for authentication:* Creates unique digital signatures to ensure document authenticity.

12.3. Limitations and challenges of digitalization

**High costs:* Requires high-quality scanners and software;

Data storage and security: Long-term storage of large files requires continuous technical infrastructure;

Complex format issues: Some historical documents may be difficult to convert into a digital format.

13. Preventive conservation and its importance

Preventive conservation refers to the set of measures implemented to prevent further damage to documents. Unlike restoration, preventive conservation focuses on ensuring the longevity of documents with minimal physical intervention (Ismayilov, Ismayilov & Mammadova, 2019).

13.1. Key aspects of preventive conservation

Climate and humidity control: Temperature (18-22°C) and humidity (45-55%) should be maintained consistently in archive rooms;

Lighting and UV protection: Sunlight and artificial light can damage paper materials, so UV filters should be used;

Physical protection andproper storage: Acid-free folders, specialized archival boxes, and non-acidic wrapping materials should be used;

Biological hazard prevention: Regular inspections and disinfection of the environment to protect documents from mold, fungi, and pests;

Minimizing mechanical wear: Special gloves should be worn when handling fragile and old documents.

13.2. Application of new technologies in preventive conservation

Climate-controlled smart sensor systems: IoT-based sensors monitor temperature and humidity in real time.

Nanotechnology: Nano-deacidifying particles are used to stabilize paper and ink (Ismayilov & Khalafova, 2022b)

Plasma-based sterilization: Applied as a safe alternative method for biological contamination removal;

UV-C disinfection systems: Protects documents from microorganisms.

By leveraging these advanced techniques and technologies in digitalization and preventive conservation, archival materials can be effectively preserved for future generations. These innovations provide a better balance between maintaining physical materials and making them accessible for study and education.

14. The Interrelationship Between Digitalization and Preventive Conservation

Digitalization and preventive conservation together form modern approaches in document management. When applied simultaneously, they ensure both physical and digital preservation of documents. Here's a comparison of their characteristics:

Comparison Criteria	Digitalization	Preventive Conservation
Objective	Creating digital versions of physical documents	Preventing further physical damage to documents
Method	Scanners, OCR (Optical Character Recognition), 3D modeling	Climate control, environmental disinfection
Advantages	Electronic protection, remote accessibility	Long-term physical protection
Limitations	High technical and financial costs	Some damages may not be fully preventable
Application Area	Digital archives, scientific research institutes	Physical archives, museums, libraries

Combined application: The integration of both approaches ensures the protection of documents in both physical and digital formats. Digitalization helps to safeguard and share documents widely, while preventive conservation ensures their physical durability in the long term (Kenzhebayeva, Urmurzina & Mahammadli, 2018).

15. Conclusion and recommendations

**Conclusion:*

Digitalization and preventive conservation measures are complementary approaches in the preservation of archival documents. Digitalization ensures the creation of electronic versions of documents, facilitating their use and protection, while preventive conservation helps extend the physical lifespan of documents.

**Recommendations*:

**Use of high-quality scanners and OCR systems*: To ensure the best results in digitalization, it is essential to use high-quality scanners and Optical Character Recognition (OCR) systems (Alekper & Tofig, 2020).

Climate control and modern conservation materials: Smart sensors for climate control and the use of modern conservation materials should be implemented in archives to maintain optimal conditions for document preservation (Rzayeva, 2024).

Development of Blockchain and AI-Based Archive Management Systems: Blockchain technology for document authentication and AI-based systems for archive management should be developed and integrated into the preservation process;

Continuous Training for Archive Staff: Regular training for archive staff on new technologies and conservation techniques is crucial to maintaining the integrity and effectiveness of the preservation efforts.

International Best Practices-Based Recommendations:

Based on the best practices of leading archives and libraries around the world, the following recommendations have been formulated. These align with the standards of international organizations such as UNESCO, IFLA (International Federation of Library Associations), ICA (International Council on Archives), and other relevant bodies:

16. International Standards and Practices for Archive Document Preservation

16.1. Climate Control

UNESCO and IFLA recommendations. To ensure the long-term durability of materials stored in archives, stable temperature and humidity levels must be maintained. The specific environmental conditions depend on the type of material being preserved. In modern archives, IoT-based climate control systems should be applied to continuously monitor and adjust environmental conditions (Qasımlı & Məhəmmədli, 2024a). Notable examples include the National Archives of the UK and US National Archives, where advanced technologies are used to ensure optimal preservation environments.

These climate control measures are critical for minimizing the risk of degradation, ensuring that archival materials are preserved for future generations. Implementing such systems helps in tracking and controlling the environment in real-time, thus preventing any potential damage caused by fluctuating temperature or humidity levels (Rzayeva & Balayeva, 2024).

Collaboration and knowledges sharing. International collaboration and sharing of best practices between archives and institutions will lead to the development of more effective conservation techniques and digitalization methodologies.

**Standardization of preservation protocols*.* Adopting standardized preservation and conservation protocols across international archives will ensure consistency and the long-term sustainability of archival materials.

**Emphasis on research and development:* Investment in research and development of new preservation materials and techniques is essential for keeping up with the rapidly evolving nature of technology and environmental challenges.

**Sustainability in Preservation Practices:* Environmental sustainability should be a priority in both physical conservation and digitalization efforts, ensuring the use of eco-friendly materials and energy-efficient technologies (Rzayeva, 2023).

By incorporating these recommendations, archives can better preserve cultural heritage and improve access to valuable documents for future generations.

16.2. Physical Preservation and Protection

**ICA and Library of Congress (USA) Recommendations:* To ensure the physical integrity of archival materials, several preservation practices should be followed:

**Use of Acid-Free Folders and Special Storage boxes:* Materials should be stored in acid-free containers to prevent the acid from degrading paper and other materials over time;

**Application of ultraviolet light filters and controlled lighting systems:* UV light can cause significant damage to archival materials, especially paper and photographs. Therefore, it is recommended to use UV filters and specific lighting systems that limit exposure to harmful light wavelengths (Ismayilov, Mahammadli, & Khudiyeva, 2022).

**Storage in closed, protected systems instead of open shelving:* It is recommended to store documents in closed, climate-controlled environments rather than on open shelves. This practice minimizes the risk of physical damage and exposure to environmental factors. The Bundesarchiv (Germany) is a notable example where such methods are actively employed to ensure materials are kept in secure, controlled conditions (Ismayilov, Mahammadli & Gasimli, 2023a).

These recommendations are essential for extending the lifespan of documents and other archival materials, protecting them from environmental and physical degradation.

16.3. Preventing Biological Damage

FAO and ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) recommendations:

To prevent biological deterioration such as mold growth and insect infestations, the following strategies are recommended:

- *Application of biological decontamination methods:* To combat biological threats like mold and insects, biological decontamination methods should be applied. For example, CO_2-based fumigation and UV-C lighting are effective in eliminating pests and mold without causing harm to the archival materials.
- *Installation of filtration and ventilation systems in closed archive systems:* Proper air circulation and control of environmental factors are essential for preventing biological damage. Archives should implement filtration and ventilation systems in controlled environments to maintain optimal conditions. An example of this is the National Archives of France, where such systems are utilized to protect archival materials from biological threats (Tofiq, Oqlu & Kazimi, 2022).

17. Digitalization Best Practices and Recommendations

17.1. Quality Standards for Digital Archives

- *ISO 19005 (PDF/A Standard)* – This international standard recommends the use of PDF/A format for long-term preservation of archived documents. PDF/A is a special version of the PDF format that ensures the document will remain accessible and usable for long periods, even as technology evolves. It is designed to ensure that all necessary information (e.g., fonts, colors, layout) is embedded in the file, ensuring its readability and accessibility in the future;
- *ISO 14721 (OAIS - Open Archival Information System)* – This standard outlines a framework for the management of digital archives, known as the OAIS model. The OAIS model defines a comprehensive methodology for the long-term preservation and accessibility of digital records. It provides guidelines for structuring and organizing digital archives, including data formats, metadata, and systems for storage and access. It is widely accepted by institutions and organizations for the digital preservation of archival materials (Karabalina, Maydangalieva, Satygalieva, Ahmetalina & Mahammadli, 2018).

**European and US Practices in Digitalization:*

18. High-Resolution Scanning Standards

*British Library and the US Library of Congress recommend using scanning resolutions above 600 dpi for the digitization of archival materials. This ensures the preservation of high-

quality digital copies that maintain the fine details of documents, which is essential for long-term access and study

*AI-Based OCR Systems:The use of AI-based OCR (Optical Character Recognition) systems is highly recommended to enhance the accuracy and efficiency of converting scanned documents into searchable and editable text. Notable examples include:

**Google's Transkribus:* A leading AI-powered transcription and document analysis tool, specialized in historical documents and handwritten texts (Ismayilov, 2022).

**Tesseract OCR:* An open-source OCR engine that supports over 100 languages and provides a reliable method of digitizing historical and contemporary texts (Mahammadi, 2024).

19. Blockchain for Document Authentication and Preservation

Blockchain technology has been integrated into archival practices, with Estonia's E-Archive System being a prominent example. Blockchain ensures the authenticity and security of digital documents by creating an immutable record of every action taken on a document (e.g., access, edits, transfers). This method helps in preventing tampering, verifying document integrity, and ensuring long-term preservation in a highly secure manner (Kushzhanov & Mahammadli, 2019b). These practices exemplify the integration of modern technologies to ensure the efficient, secure, and accurate preservation and access to digital archives. By combining high-quality scanning, advanced OCR systems, and blockchain for verification, these institutions maintain the reliability and integrity of their digitized records. These standards ensure that archived digital materials are preserved in formats that support long-term accessibility, integrity, and usability, ensuring that important records are not lost to technological obsolescence (Kazimi, Abdullayeva & Ismayilov, 2020).

**Digital document storage and security:*

**ICA and UNESCO recommendations:*

19.1.Multi-layered backup systems:

It is recommended to implement multi-layered backup systems for the long-term security and preservation of digital documents. These backups should include:

**Secure servers:* Ensuring that data is stored on reliable, highly-secured servers (Ismayilov & Khalafova, 2022a).

**Cloud storage:* Leveraging cloud-based solutions to ensure remote and safe backup (Məhəmmədli, 2024a).

**Magnetic storage devices:* Including magnetic tapes and hard drives as additional offline storage solutions to mitigate the risk of data loss from online threats (Heydar, 2023).

19.2. Cryptographic identifiers (MD5, SHA-256)

He use of cryptographic hash functions like MD5 and SHA-256 is essential for document integrity and authentication. These functions generate unique digital fingerprints of files, ensuring that they haven't been altered or tampered with. The US National Archives and Records Administration (NARA) applies these methods to guarantee the authenticity and long-term reliability of its digital records (İsmayılov & Məhəmmədli, 2024).

19.3. Automated metadata systems

*The use of automated metadata systems is vital for the efficient organization and searchability of digital documents. Recommended metadata standards include:

**Dublin Core:* A standard for describing a wide range of resources with a focus on simplicity and interoperability (*Мухаммадли, 2023).*

**METS (Metadata Encoding and Transmission Standard):* A framework for encoding metadata that can be used in digital preservation and library management systems (Balayeva, 2020).

**MODS (Metadata Object Description Schema):* A schema for representing descriptive metadata in a structured format that can support long-term archival and access purposes (Mahammadli, 2018).

These recommendations emphasize the importance of combining technological solutions and international best practices to secure and maintain digital records in the long term (Ismayilov & Aliyeva, 2023; Ismayilov & Khalafova, 2023). By integrating multi-layered backup strategies, cryptographic security, and metadata systems, archives can ensure the durability, authenticity, and accessibility of their digital collections (Kushzhanov & Dashgin, 2019a).

20. Preventive conservation and risk management: international practices

20.1. Disaster prevention and risk planning

**UNESCO and ICA recommendations:*

20.2.Fire and Water Damage Protection Systems

*Archives should implement comprehensive protection systems to prevent fire and water damage. These systems are crucial to safeguarding valuable historical documents;

*Archives, such as those at the British Library, install fire-resistant and water-resistant automatic systems to protect their collections in the event of a disaster. These systems include advanced fire suppression techniques and flood prevention measures that automatically activate in case of emergency (Bayramov & Hasanova, 2024).

20.3. Digital and physical backup copies

In the event of disasters, it is essential to create backup copies of documents. These copies should be stored in both digital and physical formats to ensure access in case one method of preservation is compromised (Kushzhanov & Dashqin, 2019c).

Digital backups can be stored off-site or in cloud storage, while physical backups may be kept in remote locations or protected environments, ensuring redundancy in preserving the records (Balginova, Maydangalieva, Satygalieva & Mahammadli, 2018).

These recommendations emphasize proactive planning for natural and man-made disasters. Archives should not only focus on disaster recovery but also take preventative steps, such as installing fire and water protection systems, and creating both physical and digital backup copies to ensure the long-term survival of valuable documents (Kazimi & Mahammadli, 2021).

20.4. Electronic management of archives and application of artificial intelligence (AI)

*Artificial Intelligence and Automation:
Leading institutions such as the British Library, Library of Congress, and the European Archives Consortium have been incorporating AI and machine learning (ML) models into their archives management systems for tasks like document classification and optical character recognition (OCR) (Nadir & Sevda, 2022). These technologies enable more efficient processing, improved accuracy in digitization, and easier access to archival materials (Bayramov & Hasanova, 2022).

Recommendations:

**Automated Content Analysis Systems for Digital Archives:*

Implement automated content analysis systems that leverage AI to facilitate the search process. Such systems would automatically analyze and categorize content, making it easier for researchers and users to find relevant information in digital archives. This is particularly helpful in large-scale digitization projects where manual indexing and searching would be too time-consuming and inefficient (Ismayilov, Mahammadli & Gasimli, 2023b).

**AI-Powered Text Recognition Tools for Document Classification:*

Use AI-driven text recognition tools to classify documents based on their content. These tools can automatically recognize, categorize, and tag text within scanned documents, improving the accuracy and efficiency of the archival process. They can also aid in identifying

historical documents based on linguistic patterns, context, and other metadata, streamlining the management of vast digital collections.

By utilizing AI and ML technologies, archives can significantly enhance their document management processes, making them more efficient and user-friendly while ensuring that valuable historical records are preserved and accessible for future generations (Kazimi & Agamirzaev, 2021).

**Recommendations based on İnternational Practices:*

**Conservation Strategy in Line with Global Standards:*

*Climate control systems in archives should be installed in accordance with international conservation standards;

*Plasma sterilization and nanotechnology-based protection methods should be implemented.

**Improving quality in the digitization process:*

*OCR and artificial intelligence-based text recognition technologies should be used;

*Digitized documents should be stored in PDF/A, TIFF, and XML formats (Ismayılov & Khudiyeva, 2023).

*International metadata standards (Dublin Core, METS) should be applied.

**Risk management and emergency preparedness:*

- Backup copies of documents should be stored in different geographical locations (Kazimi & Balayeva, 2024).

*Fire and water-resistant archive rooms should be created (Qasımlı & Məhəmmədli, 2024b).

**Application of New Technologies:*

*Document authentication should be carried out using blockchain technology (Khalafova & Ismailov, 2024);

*AI-based archive management and search systems should be established.

Conclusion

International practices show that preventive conservation, digitization, and risk management should be implemented together for the protection of archival documents. Standards from organizations such as ISO, UNESCO, and ICA should be followed in archive management, and modern technologies like AI and Blockchain should be integrated into the system. The correct selection of restoration and conservation methods ensures the longevity of archival documents. While preventive measures help preserve documents for a longer period,

restoration methods are aimed at returning already damaged documents to their original condition. Digital methods and innovative technologies open new possibilities in document management. The application of modern technologies for the preservation of paper, parchment, and other archival materials helps extend their lifespan. Nanotechnology, plasma treatment, multispectral imaging, and AI-based restoration methods are opening new opportunities in document management. The broader application of these technologies could bring revolutionary changes in the preservation of archival documents.

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