

Preservation Strategies for Photographic Collections in Tropical Climates: Evaluating practices at Sonobudoyo Museum

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Abstract

This study assesses preservation strategies for photographic collections at the Sonobudoyo Museum in Yogyakarta, Indonesia. The museum faces challenges from the tropical climate, including high humidity, mould, and temperature fluctuations, which damage materials. Through observations and interviews, the research identified key issues in current storage and environmental control practices. The findings emphasise the need for affordable, climate-adapted solutions. This study proposes a practical preservation framework tailored to tropical environments, along with recommendations for consistent environmental monitoring. The framework offers insights for other heritage institutions in Southeast Asia to support the long-term preservation of photographic artefacts.

Keywords: Environmental monitoring, museum collections, photographic preservation, tropical climate

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1.0 Introduction

The Sonobudoyo Museum in Yogyakarta is a regional museum that houses approximately 65,000 collections from various regions in Java, Bali, Madura, and Lombok. Among these collections, 9,776 are photography collections. Although it remains underexplored, most of the photography collection was donated by the Java Instituut, a cultural research institute established during the Dutch East Indies era, which documented the social and cultural life of Java, Bali, Madura, and Lombok. The photography collection not only serves as visual documentation but also as a historical source that records traditional culture, important moments, social events, and portraits of individuals and communities during the colonial period. The documentary and historical value of this collection makes it a significant cultural asset. Therefore, the preservation and conservation of the Sonobudoyo Museum's photography collection are essential to ensure continued access to historical information and visual cultural heritage for future generations. As a museum situated in a tropical region, the Sonobudoyo Museum faces challenges posed by its environment's unique characteristics. According to Teygeler et al. (2001), the process of material deterioration in tropical climates is very complex because it involves various physical, chemical, and biological factors that mutually accelerate the rate of degradation, especially when high temperatures and relative humidity are left uncontrolled. The combination of heat, humidity, and exposure to ultraviolet light creates ideal conditions for oxidation, mould growth,

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and insect infestation, making tropical environments far from the ideal standard of museum and library conservation. If these conditions are not controlled, the museum's cultural assets will be further damaged and eventually lost.

This study aims to evaluate the preservation strategies applied to the photographic collection at the Sonobudoyo Museum in Yogyakarta. The primary focus is on how the museum manages its storage systems, implements microclimate control, and cares for the collection. This evaluation is particularly relevant, as photographic materials are highly susceptible to fluctuations in temperature and humidity conditions that are characteristic of tropical environments. Using a qualitative approach based on field observations and interviews, the research aims to identify the key challenges faced in preserving photographic materials, assess the effectiveness of current preservation methods, and propose practical approaches that can be implemented within museums operating in tropical regions. This study aims to support the development of preservation strategies for photographic collections in the tropics, including at the Sonobudoyo Museum and similar institutions.

2.0 Literature Review

Previous studies related to photographic conservation in Indonesia, particularly at Museum Sonobudoyo, remain limited. Research by Isradina Paricha (2022) at the Sonobudoyo Museum analysed samples of old self-portrait photographs. Her research revealed that the collections exhibited various forms of damage, including mould, stains, tears, and colour changes, all of which were caused by humidity. Treatment was carried out through mechanical cleaning, patching, and restorage. Research by Ekarini (2023) analysed four samples of photos from the Sonobudoyo Museum using macroscopic and microscopic techniques, including pXRF (portable X-ray fluorescence) and FTIR (Fourier-transform infrared), which revealed that all samples employed silver gelatin printing materials. The study also employed conservation methods, including dry cleaning and storage on mounting boards. Additionally, Winda Diah Puspita Rini (2021) examined the collection of glass negatives in the Borobudur conservation archive, which has been recognised as a Memory of the World (MoW) item. Through SEM (Scanning Electron Microscope), FTIR, and SEM-EDX (Scanning Electron Microscopy-Energy Dispersive X-Ray) analysis, the glass negatives were identified as gelatin dry plates that had undergone severe degradation, including emulsion loss, peeling, and silver mirroring. Conservation of this collection prioritises environmental stability and specific cleaning using alcohol and soft abrasive materials. Marpaung (2012) reported conservation efforts on colonial-era glass negatives, emphasising the importance of physical cleaning and systematic cataloguing of thousands of images from the Dutch East Indies Archaeological Office (Oudheidkundige Dienst).

Mariato et al. (2024) showed how curatorial strategies preserve artistic ideology, while Legino et al. (2024) documented ARCADESA 2024 as a platform for safeguarding regional creative heritage through dialogue and collaboration. Both perspectives align with the photographic preservation study at Sonobudoyo Museum, reinforcing that effective preservation in tropical museums must integrate technical care with cultural interpretation and collective knowledge exchange. This aligns with the study on photographic preservation at Sonobudoyo Museum, where conservation is not only technical but also interpretative—aimed at sustaining cultural meaning and collective memory. Overall, these studies indicate that photography conservation requires an interdisciplinary understanding of materials science, the environment, and technology. Classic challenges such as resource constraints, funding, and the tropical climate that accelerates biodeterioration remain major obstacles in conservation practices at many institutions.

2.1 Environmental Challenges of Photographic Conservation in Tropical Climates

Photographic materials are among the most fragile categories of cultural heritage objects, particularly when stored in environments characterised by high humidity, elevated temperatures, and biological threats, which are conditions typical of tropical climates. Their vulnerability stems from the inherent instability of components such as silver-based prints, gelatin emulsions, and cellulose acetate supports, which are highly prone to both chemical and biological deterioration (Getty Conservation Institute, 2015).

Tropical regions, such as Southeast Asia, experience relative humidity (RH) levels that frequently exceed 70%, with average temperatures ranging from 25°C to 32°C throughout the year. These climatic conditions significantly accelerate the degradation of photographic materials (Teygeler et al., 2001). High humidity can soften gelatin emulsions, causing prints to adhere to one another, while also promoting fungal growth (Canadian Conservation Institute, n.d.). This biological risk is exacerbated in storage spaces that lack proper ventilation and environmental monitoring. The Canadian Conservation Institute (2002) recommends maintaining RH between 30% and 50% for photographic collections, noting that tight environmental control is especially important in tropical climates. Padfield and Borchersen (2007) also emphasise that passive climate control, such as buffering with silica gel in sealed cabinets, can be highly effective when active HVAC (Heating, Ventilation, and Air Conditioning) systems are not feasible.

In addition, elevated temperatures accelerate the chemical reactions that contribute to material breakdown. Heat plays a crucial role in driving chemical reactions (Conservation Center for Art & Historic Artifacts, 2022). A temperature increase of just 10°C can double the rate of chemical degradation (Teygeler et al., 2001). This is particularly problematic in storage areas without climate control, where daily temperature fluctuations can lead to repeated expansion and contraction of photographic layers, resulting in cracking, image distortion and fading of color photographs (Conservation Center for Art & Historic Artifacts, 2022). Tropical climates also support the proliferation of destructive insects such as cockroaches and silverfish, and contribute to fungal growth. When combined with high humidity, these agents can cause staining, perforation, or even complete loss of image content (Teygeler et al., 2001).

3.0 Methodology

This study was conducted at the Sonobudoyo Museum in Yogyakarta. The museum was selected as the case study because it houses a photographic collection documenting Javanese culture, colonial history, and ethnographic and archaeological activities, while operating under the challenging conditions of a humid tropical climate. This study uses a qualitative descriptive approach with an analytical framework based on comparative condition assessment and environmental evaluation to examine the museum's preventive conservation strategies for photographic collections. From a total of 87 conserved paper print photographs, a purposive sample of 26 objects was selected for detailed analysis. The samples were chosen based on variation in damage types, severity levels, and mounting conditions to represent the overall condition of the conserved collection. Data were collected through direct observation, interviews, environmental monitoring records, and document analysis. Observations focused on the physical conditions of Storage Room D, where the photographic archives are housed. Interviews were conducted with one conservator and one curator to gain in-depth insights into the museum's conservation practices. The analysis focused on examining the conservation strategies implemented at the museum through object condition assessment and environmental evaluation. This triangulated methodological approach provided a comprehensive understanding of how photographic conservation strategies are applied at the Sonobudoyo Museum.

4.0 Findings

4.1 Overview of the Photographic Collection

The photographic collection at the Sonobudoyo Museum consists of film negatives, glass plate negatives, and paper-based photographic prints. To date, the total number of items in the collection has reached 9,776. These photographs capture a variety of subjects, including archaeological sites, cultural objects, traditional art performances, natural landscapes, building architecture, and portraits of individuals and groups. This collection serves as an important visual archive in documenting the history and cultural heritage of Java, Bali, Madura, and Lombok. The museum's database includes basic details like object names, inventory numbers, descriptions, and photos but lacks in-depth data on printing materials, techniques, content, date, and provenance. Initial efforts to analyse the photographic material began in 2022 and continued until 2023. The research was conducted by Ekarini (2023) on four samples of paper prints, as well as by the Museum Sonobudoyo's internal conservation team on 84 other samples. Based on visual and technical analysis, three types of photographic materials were identified: collodion prints, carbon prints, and silver gelatin prints.

4.2 Current storage conditions

Around 2018, the museum relocated its collection storage to a new building with improved environmental control, although the condition of the collections prior to the move is undocumented. In the new storage, organisation and documentation systems were enhanced. Each storage unit is assigned standardised codes and collection call cards placed on shelves, facilitating physical tracking and supporting the museum's internal digital database.

Photographic archives are housed in cabinets in Storage Room D (Fig. 1). Printed photographs are kept in labelled albums stacked together, some mounted on boards. Glass plate negatives are stored in compartmentalised wooden boxes. The photo albums vary in form and arrangement: some photographs are clipped into paper frames, others are glued using unidentified adhesives; some are corner-mounted with paper cutouts, while others are inserted behind perforated paper sheets. Album pages are generally lined with acid-free protective paper, as shown in Fig. 2.

4.3 Condition Assessment and Deterioration Factors

The types of damage identified in the printed photograph collection include various forms of deterioration, such as tears, mould growth, staining, discolouration, image fading, and silver mirroring, which is characterised by blackish stains on silver-based areas, as shown in Fig. 3. As for glass plate negatives, observed damages include breakage, cracks, and emulsion delamination. According to museum staff, the damage to the photographic collection probably began while it was still stored in the old storage room, before being moved to the new facility.



Fig. 1. (a) storage cabinet; (b) storage for paper printed photo albums; (c) storage for glass plate negatives
(Source: Author's documentation, 2025)

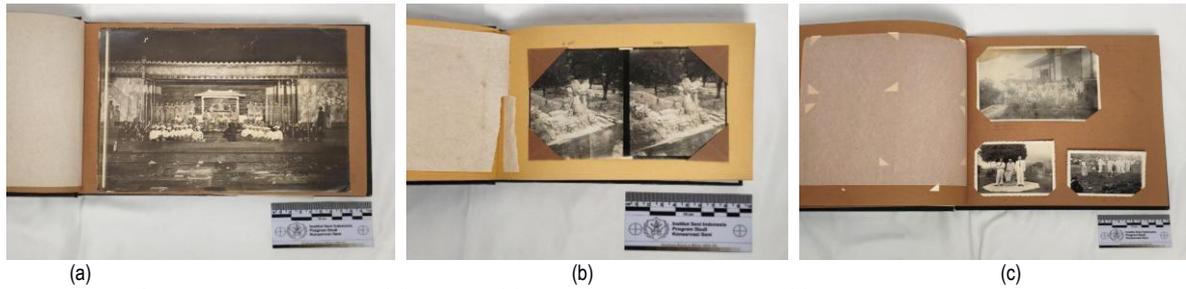


Fig. 2. Paper mounting method: (a) use glue; (b) paper frames at each corner; (c) corners tucked into paper holes
(Source: Author's documentation, 2025)



Fig. 3. Examples of damage to (a) paper-based photographic prints, and (b) glass plate negatives
(Source: Author's documentation, 2025)

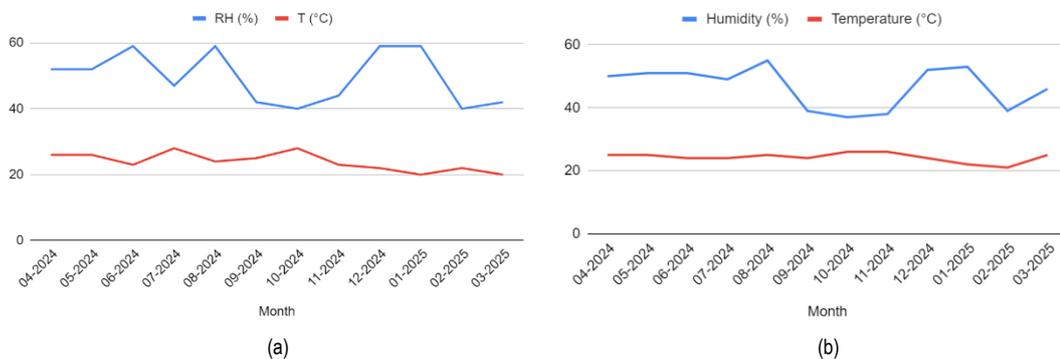


Fig. 4. Average Temperature and Relative Humidity in (a) Storage Room D; and (b) Internal Storage Cabinet
(Source: Processed from daily IoT logs (April 2024 – March 2025), Sonobudoyo Museum)

To mitigate the risks associated with the tropical climate, the Sonobudoyo Museum has implemented a microclimate control strategy in its new storage facility. To support environmental stability, thermohygrometers integrated with an IoT-based monitoring system have been installed in both the general storage room and inside the storage cabinets. This system continuously records and stores hourly data on temperature and relative humidity, enabling real-time monitoring and long-term environmental analysis.

Fig. 4 shows the recorded microclimate data in Storage Room D and the storage cabinets over a twelve-month period, from April 2024 to March 2025. This timeframe represents a complete annual cycle, covering both the dry season (April to September) and the wet season (October to March). Based on daily data logs, relative humidity in the storage room ranged from 40% to 59%, with temperatures between 20°C and 28°C. The storage cabinets, in comparison, maintained slightly more stable conditions, with humidity levels ranging from 37% to 55% and temperatures between 21°C and 26°C. On average, the storage room recorded a temperature of 24°C and relative humidity of 50%, while the cabinet averaged 24.5°C and 47% humidity. These differences highlight the cabinet's greater ability to regulate microclimatic conditions throughout the year.

During the dry season, both the storage room and cabinet maintained an average temperature of 25°C, though the room had slightly higher relative humidity (52%) compared to the cabinet (49%). During the wet season, the storage room exhibited a more pronounced drop, with an average temperature of 23°C and a relative humidity of 47%, while the cabinet remained more stable at 24°C and 44%. These results show that the cabinet offers a more consistent and controlled microenvironment. Its lower and more stable humidity levels are especially beneficial for preserving photographic materials by reducing the risk of mould, emulsion softening, and other moisture-related damage.

4.3 Conservation Practices at Sonobudoyo Museum

In 2023, the Sonobudoyo Museum conducted conservation treatment on 87 paper print photographs out of a total of 9,776 in its collection. No conservation work has been done on film or glass negatives. The treatments aim to stabilise the physical condition of the

photographs and prevent further deterioration. Procedures include condition reporting, documentation, and surface cleaning using a soft brush and smoke sponge to remove dirt. Condition reports record the physical state, damage, and dimensions of each photograph. Documentation involves capturing digital images and metadata. Surface cleaning helps slow deterioration and preserve the photograph's visual clarity.

In addition to curative treatment, the museum has also implemented preventive conservation measures by creating storage frames made from acid-free mounting boards. These frames help protect old photographs from direct exposure to potentially damaging environmental conditions. The T-hinge mounting technique is used behind the photographs, along with a window mat. This method allows the photograph to hang freely while the mount is invisible from the front, ensuring both protection and a clean visual display. For adhesives, the museum uses Japanese paper and Weizen Stärkle Paste (WSP) as conservation materials. An example of the mounting board is shown in Fig. 5.



Fig. 5. Making mounting boards for a collection of printed photographs
(Source: Author's documentation, 2025)

5.0 Discussion

The most significant issues affecting photographic preservation in tropical museum environments are environmental instability, particularly high temperatures and fluctuating relative humidity, which accelerate chemical and biological deterioration processes in photographic materials (Calanno & Tse, 2025; Melbourne Asia Review, 2025). In addition, inappropriate handling practices have been widely recognized as contributing factors to physical and chemical damage in photographic collections (NEDCC, 2022). These problems are evident in Indonesian institutions, where several studies have documented the vulnerability of photographic collections to tropical conditions. At the Sonobudoyo Museum, Paricha (2022) identified various forms of deterioration in printed photographs, including mould, stains, tears, and colour changes, all primarily caused by high humidity. The study demonstrated that conservation treatments such as mechanical cleaning, patching, and restorage were necessary to stabilise the objects. Ekarini (2023) analysed photographic samples from the same museum using macroscopic and microscopic techniques, confirming that the materials were silver gelatin prints. That research highlighted the importance of appropriate cleaning methods and improved storage systems for preventing further damage. Comparable findings were reported by Rini (2021) in the Borobudur Conservation Archive, where glass plate negatives exhibited severe degradation such as emulsion loss, peeling, and silver mirroring. Earlier work by Marpaung (2012) on colonial-era glass negatives also stressed the need for systematic cleaning, cataloguing, and preventive storage management. Together, these studies confirm that environmental control and preventive conservation are critical priorities for photographic heritage in Indonesia. In response to these risks, the preservation strategies implemented at the Sonobudoyo Museum focus on preventive conservation measures, including storage management, microclimate control, and appropriate handling and treatment procedures. The following discussion evaluates the effectiveness of these strategies in addressing the challenges of preserving photographic materials in the museum.

Post-treatment observations indicate that current conservation practices are generally effective. Visually, the surface of cleaned photographs appears cleaner and free of dust and fine particles. When cleaning with a smoke sponge, it is necessary to consider the type of photographic material and the extent of damage to the emulsion layer. According to the Eastman Kodak Company (1985), knowledge of the emulsion type is essential before any cleaning is undertaken. Each object must undergo a careful cleaning process to remove dry dirt and oil residues from both the image surface and the reverse side. The use of cotton gloves is recommended when handling photographic objects, and initial cleaning should be performed using a soft camel-hair brush. If the emulsion type is unknown, liquid cleaning is not recommended to avoid irreversible damage.

The use of mounting boards has proven effective in reducing the risk of physical deformation and exposure to environmental fluctuations. However, the application of adhesive Weizen Stärkle Paste (WSP) directly to photographic materials may pose long-term risks. Non-adhesive mounting techniques, such as the use of mounting corners (McGlinchey, 2010), offer a safer preventive alternative. For severely damaged objects, the use of non-acidic and non-lignin paper envelopes without adhesives is strongly recommended (Northeast Document Conservation Center, 2007, revised 2018). Many photographs at the Sonobudoyo Museum remain stored in original albums with aged adhesives, which can yellow, become sticky, and penetrate paper fibres. As indicated by previous Indonesian studies, such historical storage practices significantly contribute to deterioration (Paricha, 2022; Ekarini, 2023). Any relocation of photographic objects into new storage systems therefore requires careful preparation and material testing.

Glass plate negatives require special handling due to their fragility. They should be stored vertically with rigid dividers and housed individually in archival containers rather than original wooden boxes, which may warp over time. This approach is consistent with

international guidelines recommending four-flap enclosures for glass negatives (NEDCC, 2007, revised 2018; 2019) and directly addresses the problems observed in Indonesian glass negative collections (Rini, 2021; Marpaung, 2012).

Environmental data from the Sonobudoyo Museum, presented in Figure 4, show that both the storage room and cabinets maintain relatively stable microclimate conditions. Average relative humidity of around 47–50% and temperatures near 24°C fall within recommended ranges for photographic preservation. These conditions significantly reduce the risk of mould growth and pest activity, which typically require higher humidity levels (Orlik-Koźdoń, 2020; Consortium for Heritage Collections and Their Environment, 2020). Such stability directly addresses the environmental problems previously identified in Indonesian collections, where humidity was repeatedly cited as the main cause of deterioration. The Canadian Conservation Institute (2002) recommends maintaining relative humidity between 30% and 50% for photographic materials and emphasises the importance of tight enclosure systems to minimise fluctuations. The current environmental control strategy at the Sonobudoyo Museum therefore aligns well with international preventive conservation standards.

Overall, compared with earlier studies that focused mainly on documenting damage and remedial treatments, current practices at the Sonobudoyo Museum demonstrate a stronger shift toward preventive conservation. Improved microclimate management, better storage systems, and more standardized handling procedures indicate meaningful progress in the long-term preservation of photographic collections in Indonesia.

6.0 Conclusion and Recommendations

This study evaluated the preservation strategies for photographic collections at the Sonobudoyo Museum in Yogyakarta, focusing on the challenges posed by tropical climates. The findings reveal that the museum has made significant progress in controlling environmental conditions through the use of IoT-based temperature and humidity monitoring systems, as well as preventive measures such as acid-free mounting and improved storage organisation. These strategies have helped maintain stable microclimate conditions that significantly reduce the risk of deterioration.

However, the research also identifies ongoing issues, including the limited scope of conservation treatments. Only a small portion of the total 9,776 photographs has received curative attention, while the majority of the collection remains untreated, including film and glass plate negatives. The presence of outdated adhesives in some original albums also presents long-term preservation risks. Additionally, the current storage system does not yet fully accommodate material-based grouping, which limits the efficiency of targeted conservation actions. Digitalisation efforts remain limited, which increases the risk of deterioration due to repeated physical handling and environmental exposure.

To address these issues and support sustainable preservation, this study recommends expanding conservation efforts to all material types, particularly glass and film-based photographs. The use of non-adhesive, reversible mounting techniques is advised to prevent chemical degradation. Reorganising storage based on material characteristics will support more systematic preservation planning. Accelerated digitisation can reduce handling of fragile originals, while ongoing technical training and cross-institutional collaboration are vital for long-term conservation capacity. Together, these strategies provide a practical roadmap for the Sonobudoyo Museum and other tropical-region institutions facing similar environmental challenges. This study is limited by its focus on a single institutional case, restricting the generalisability of the findings. Additionally, only a small portion of the photographic collection received curative treatment, with film and glass plate negatives remaining underrepresented.

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Paper Contribution to the Related Field of Study

This study offers practical insights into preserving photographic collections in tropical climates through a case study at the Sonobudoyo Museum. It emphasises IoT-based environmental monitoring, preventive conservation, and material-based storage strategies, contributing to climate-adapted preservation practices relevant to museums in Southeast Asia.

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