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RESEARCH ARTICLE

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RESTORATION OF THANGKA PAINTINGS OF ERDENE ZUU MUSEUM

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ABSTRACT

In this study, the survey of registration data of thangka paintings from the Erdene Zuu Museum of Kharkhorinsoum, Uvurkhangai Aimag restored at the National Center for Cultural Heritage between 1988 and 2020 has been carried out and the results are analyzed to provide quantitative evidence of thangka paintings restored during specific years, identify which conservators carried out the restorations, and analyze the methods and materials they used; and determine whether those restoration methodologies and techniques remain appropriate up to the present time. A total of 37 thangka paintings were restored between 1988 and 2020, of these 12 paintings had sufficient documentation for analyses of the types of damage at the time they were submitted for restoration. The damages of these paintings were classified into five main categories comprising 30 individual types. Based on the results of the damage analysis, the five main damage type categories were ranked from most to least frequent, and the causes of these damages were identified. The analysis of damages of 24 thangka paintings from 37 restored thangka paintings suitable for post-restoration damage survey revealed the following common types of damage to the painting, in particular, color alteration of pigments on five paintings, paint flaking on four paintings, and detaching adhesive in a patched area on one painting. This study is of great importance for preservation and conservation of thangka paintings because it clarifies the damage types and the restoration methodologies applied. In the future, this will become part of the fundamental research on the conservation and protection of tangible cultural heritage.

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INTRODUCTION

Thangka Painting: Thangka paintings or sacred portraits of Buddha and Buddhist deities are recorded in numerous legends, historical accounts, and scriptures as having first been created in two forms known as the "Taken from Water" and the "Taken from Light". The first Thangka was called the "Taken from Water". A legend recounts that in ancient times, two eminent kings—King Udayana (often referenced as Rudrayana in some Buddhist tales) and King Bimbisara of Magadha¹ exchanged gifts to symbolize their unity and friendship. King Udayana sent a precious jeweled armor as a gift. King of Magadha was extremely pleased, but even experts could not determine the value of this gift. Unable to find an equally valuable gift in return, king became distressed. At that time, a Brahmin advised him: "Your Majesty, do not worry. The most precious and incomparable being in this world is the Buddha. Since the Enlightened One resides in your land, have his image painted and send it as a gift." Following this advice, King of Magadha asked Buddha for permission for this, and artists were summoned to create. However, artists were unable to capture the likeness of the Buddha because he emitted such a strong, brilliant, and radiant light that they

could not look at him directly. Buddha could clearly see the failing efforts of artists and to solve this, he sat by a clear lake and instructed the artists to paint his reflection in the water. This allowed the artists to capture his likeness, which was then transferred onto a piece of cloth. The resulting painting was called Thangka, meaning 'taken from water'. The portrait was placed in a golden case, wrapped in fine silk, and carried on a huge elephant accompanied by five hundred attendants to King Udayana, who received it with great reverence and built five hundred temples in its honor. About the thangka paintings "Taken from Light": At one time, merchants from Shravasti traveled to the island of Sinhala in the ocean and recited blessings of the Buddha. The princess of the Sinhala² liked it very much and asked the merchants to teach her this song or chant. When merchants explained that it was not a song but the Buddha's teaching, her devotion grew immensely. She sent gifts of seven large vessels filled with pearls to the Buddha through the merchants. The Buddha pleased and smiled, and rays of light emanated from his body. An artist then used this luminous, divine reflection as a guide to trace the exact, perfect image of the Buddha, creating the first Thangka, which was sent to the princess along with the Buddha's teachings and blessings. This image became known as the "Taken from Light", or often

¹G. Purevbat. Fundamental Knowledge of the Craft of Mongolian Buddhist Art. Volume I. Aglag Buteel Monastery, 2016, p. 27

²G. Purevbat. Basic knowledge of the Buddhist art of the Great Mongols. Volume One. Aglag Buteel in Khiid-2016. X-29

referred to as “The image of the Sage taken from the rays”. Thus the earliest thangka paintings created, and the artistic tradition of depicting numerous Buddhist deities developed over time and spread across many countries before eventually being transmitted to Mongolia. Some of the world’s earliest surviving thangka paintings preserved on cloth and walls found in the Ajanta Caves of India and the Mogao Caves in China. The Mogao Caves in Dunhuang, China, contain some of the world’s earliest surviving thangka paintings, dating back to the Tang Dynasty period (roughly 781–848 AD or 10th century)³The Mogao Caves’ contain Buddhist manuscripts, paintings, textiles, secular documents and other artifacts. The Mogao Caves, specifically the “Library Cave” (Cave 17), were sealed in the early 11th century primarily to protect a massive, sacred repository of manuscripts, paintings, and artifacts from impending destruction. There is the manuscript recording that this cave was sealed because ancient manuscripts, paintings, textiles, and other objects have Tibetan styles that influenced by Indian styles and traditions. The cultural heritage created by the Mongolian people since ancient times represents a significant contribution not only to the nomadic civilizations of Central Asia but also to world civilization. One of them is the Buddhist art, in which thangka painting constitutes a major part. From the late 16th century, Mongolian thangka paintings were produced as illustrations for scriptures, interior decorations for temples, and devotional images. They were painted on red, white, or black backgrounds (known as Martan, Gartan, and Nagtan styles) using mineral pigments containing gold and precious materials. These paintings ranged from very small to extremely large sizes and were created according to religious rituals and artistic conventions, often with symbolic exaggeration. They were framed with silk or brocade and adorned with gilded silver, copper, brass ornaments, and silk curtains⁴. Thangka painting as a valuable national cultural heritage of Mongolia has developed into a distinct and independent genre of Mongolian fine arts. Hundreds of artifacts of these precious heritage revered for their profound cultural significance, spiritual depth are actively preserved and displayed in major museums across Mongolia, available to the public. Although we continue to see and admire the magnificent cultural heritage created with meticulous artistic craftsmanship, research on their preservation, protection, and restoration has not yet been conducted sufficiently. Moreover, studies on scientifically proven new restoration methods developed for this purpose remain limited. In this study, we present the results of field survey of 31 thangka paintings restored from the Erdene Zuu Museum, focusing on the types of damage observed, the causes of those damages, and the restoration methodologies and procedures applied.

Main Part

Erdene Zuu Museum: The Erdene Zuu Monastery was established in 1580 when Avtai Sain Khan, together with his younger brother Tumenkhen Noyon met the Third Dalai Lama and, following his advice, restored an old temple located in Takhai Balgas within the ruins of the ancient city of Karakorum. Then, from 1586 to 1674, the Gurvan Zuu Temples and the Rigsum Gombo Temple were built. Between 1701 and 1705, the Ochirdari Temple, Avid Temple, and the Great Stupa complex were built. Later, from 1771 to 1792, the Tsochin Ikh Dugan and Lavrin Temple were built. In 1782, Lamrim School (dedicated to The Path to Buddha hood) was established with 50 pupils. Mongolian nobles honored themselves by building personalized temples within monasteries to secure religious merit, prestige, and political sanction, leading to a boom in temple construction, such as the Tusheet Khan’s temple, Noyon Tseveenjav’s Temple, Ochirdari Dugan Temple. By 1792s, there were 62 temples, over 500 buildings nearby, and approximately 10,000 monks. Today, 18 temples and other constructions are restored, namely Gurvan Zuu Temples, Zuu Temple, Great Stupa, and Seruun Lavrin, as well as

stone monuments from the ruins of the ancient city Karakorum. The Erdene-Zuu monastery preserves magnificent works of Mongolian painters, artists, cutters, sculptors, embroiders and craftsman of the XVII-XIX centuries, including sculptures, paintings, ornamental patterns, carvings, sculptures, cast Buddha statues, stupas, ritual vessels, incense burners, bowls, bells, vajras, finials, mandalas adorned with precious stones, Tsam masks, and ceremonial costumes. According to Mongolia’s cultural policy and government resolutions, 18 artifacts from the Erdene Zuu Monastery have been registered in the State Treasury Fund as objects of exceptional national value. As noted in the “Historical and Cultural Heritage of Mongolia” published by UNESCO the Erdene Zuu Monastery is the only monastery built according to the traditional Mongolian urban planning system, and architecturally similar to the palace structures of ancient Karakorum city. Today, the monastery attracts both domestic and international visitors throughout the year, with over 20,000 visitors annually. Erdene Zuu Monastery is surrounded by a defensive wall adorned with 108 stupas, and covers an area of 420 square meters. In 1965, the Erdene Zuu Monastery was reintroduced as a State-level Museum of Religious History according to Resolution #441 of the Council of Ministers of the Mongolian People’s Republic. Later, in 2004, the Orkhon Valley Cultural Landscape was inscribed on the UNESCO World Heritage List, recognizing its outstanding universal value and the need for its preservation for all humanity. Erdene Zuu Monastery-Museum is one of the major and most valuable monuments within the Orkhon Valley Cultural Landscape World Heritage Site.

Restoration: In accordance with this provision of the Law on the Protection of Cultural Heritage stipulating that restoration, conservation, and rehabilitation work must be carried out by authorized, qualified specialists, licensed professionals, or certified entities based on contracts and research and restoration design plans approved by the state administrative bodies in charge of cultural affairs cultural affairs⁵ the National Center for Cultural Heritage is a competent and professional body for protecting tangible and intangible cultural heritage dedicated to protecting, restoring, researching, and promoting Mongolia’s tangible and intangible cultural heritage. The National Center for Cultural Heritage has operated under several names: namely “Museum Exhibit Restoration Workshop”- in 1988, “Cultural Heritage Center” in 1995 and since 2019, “National Center for Cultural Heritage.” Within its responsibilities, this authority maintains the national unified registry and information database of cultural heritage; conducts identification of cultural properties, analysis of materials and structure, research on environmental conservation and risk factors affecting historical monuments, and condition assessments, cleaning and stabilization of archaeological artifacts discovered during excavations-either on site or in specialized laboratories, and restores museum exhibits, statues, stone monuments, and other cultural artifacts.

Registration data of thangka paintings restored from the Erdene Zuu Museum

As of 2025, according to the Unified Cultural Heritage Registration and Information System, a total of 1,022 thangka paintings are registered and preserved at the Erdene Zuu Museum in Kharkhorinsoum, Uvurkhangai Aimag. Among these, 20 thangka paintings within 18 categories are registered as exceptionally valuable historical and cultural artifacts. During field survey, an interview was conducted with D. Soyol-Erdene, who worked as a museum exhibition attendant at the Erdene Zuu Museum for 32 years (1989–2021) before retiring. She reported that no restoration work had been conducted on the thangka paintings of the Erdene Zuu Museum before 1997. Prior restoration activities were limited only to buildings, walls, fortifications, sculptures, and mural paintings of Erdene Zuu museum. She also noted that her father, N. Davaadorj, served as the museum director from 1970 to 1995, and therefore had extensive knowledge about the events and activities of the Erdene

³<https://www.potcal.org/painting-thangka>

<https://byjus.com/free-ias-prep/thangka-paintings/>

⁴Bayartur B. Unique precious. /D. Amgalan School of Fine Arts and Design of the State University of Arts and Sciences/ D. Uranchimeg. Red amulet. UB., 2017., -X44

⁵Law on the Protection of Cultural Heritage. Chapter 1, Restoration of Cultural Heritage, Section 46.1.

Zuu Museum over a 51-year period from 1970 to 2021. According to archival records from both the National Center for Cultural Heritage and the museum, the documented information confirms the registration and statistical data of thangka paintings from the Erdene Zuu Museum that were restored between 1988 and 2020. This information is presented in Table 1.

damage⁶. However, using this classification directly in the present study proved impractical because it contained too many categories, and similar damages were sometimes described using two or more closely related terms. Therefore, the classification was reorganized and simplified into 5 categories comprising 30 types of damage, as presented in Table 2.

Table 1. Registration of Restored Thangka Paintings at the Erdene Zuu Museum

#	Year	Name of the Thangka Painting
1	1997	Shambalynoron (Shambhala place)
2		Three Deities of Longevity
3		Thangka Portrait of the 5th Bogd, PuntsagshilLife Story
4		Khandchoishil
5	1998	BogdZonkhov (Tsongkhapa)
6		Buddha’s Life Story
7	1999	Chilkhanamsum (Longevity Deity)
8		BogdTsongkhapa
9	2000	Demchiggarav Thangka
10		Gunaadonrov
11		Buddha’s Life Story
12	2001	Bayan Namsrai Thangka
13		Six-Armed Mahakala Gombo Thangka
14		Demchiggarav Thangka
15	2002	Sendom Thangka
16		Makhgal Thangka
17		JanraisigThangka
18		Thangka of the Twelve Deeds of the Buddha
19		Demchig
20		Namsrai
21	2003	Daragshid Thangka
22		Gongor
23		Chadraabal
24		Damdin Jalbaa with Zamindyd Thangka
25	2004	In the Shambalynoron (Shambhala place) Thangka
26	2005	In the Shambalynoron (Shambhala place) Thangka (Framed)
27		Sanduin Jud Thangka
28		Gun Sambaa Thangka
29	2017	Avid
30	2020	Jamsran
31		Jigid Centered Ganzai

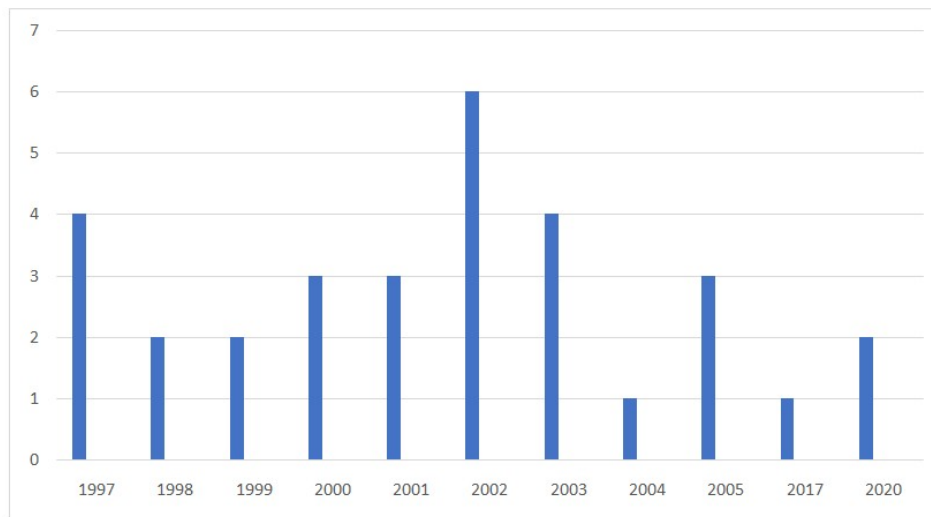


Figure 1. Thangka paintings from the Erdene Zuu Museum restored between 1997 and 2020

As shown in Table 1 above, a total of 31 thangka paintings were restored between 1997 and 2022. Among them: four paintings were restored in 1997, two- in 1998, 2 in 1999, three - in 2000, three - in 2001, six - in 2002, four - in 2003, one - in 2004, three - in 2005, one - in 2017, and two - in 2020 (Figure 1).

Damage Assessment of Thangka Paintings sent from the Erdene Zuu Museum to the National Center for Cultural Heritage: Based on the damage assessment of thangka paintings from the Erdene Zuu Museum, the damages commonly found in thangka paintings had previously been classified into 8 categories comprising 43 types of

From these 31 restored thangka paintings, 12 paintings were selected for detailed damage analysis. This selection was made because the restoration reports for these 12 paintings contained clear documentation of the damage conditions prior to restoration and descriptions of the restoration procedures carried out. The restoration reports of the remaining paintings contained only photographic documentation, which made them unsuitable for inclusion in the

⁶“Museum Studies” Journal. E. Batjargal, “Methods for Improving Preservation Conditions Based on Damage Studies of Tanka Paintings”. -UB 2019., -P.207-208.

damage analysis. The results of the damage assessment are presented in Table 3 below, where the damage classification numbers were used to indicate the specific types of damage found in each painting. For example: (1. Tselkhanamsum – 1.3, 2.1, 3.2) indicates the number and types of damages observed in that particular painting.

First: Environmental damage and ground layer damage were found in all 12 paintings included in this study. In other words, all these paintings have this type damage. Thangka paintings are created for religious purposes and are traditionally displayed in monasteries, temples, and domestic shrines for worship.

Table 2. Types and Classification of Damage in Thangka Paintings

#	Damage type	Damage classification
1	Environmental Damage	1.1. Dust contamination 1.2. Smoke and soot contamination 1.3. Contamination caused by water or liquids 1.4. Damage caused by insects or animals 1.5. Mold and fungal growth
2	Paint Layer Damage	2.1. Image loss 2.2. Color fading or discoloration 2.3. Cracking 2.4. Abrasion or flaking 2.5. Dirt accumulation 2.6. Paint detachment
3	Ground Layer Damage	3.1. Wrinkling or distortion 3.2. Tearing 3.3. Folding 3.4. Perforation 3.5. Ground layer peeling 3.6. Loss or missing parts
4	Human-Induced Damage	4.1. Overpainting 4.2. Labels or stickers attached 4.3. Adhesive or patch contamination 4.4. Oil stains 4.5. Burn damage 4.6. Scribbling or writing on the painting
5	Damage to the Silk Mounting	5.1. Fraying or tearing 5.2. Wrinkling 5.3. Dirt and contamination 5.4. Staining from liquids 5.5. Fading 5.6. Broken wooden rod 5.7. Missing wooden rod

Table 3. Damages in Thangka Paintings from the Erdene Zuu Museum Submitted for Restoration

1999			
	Museum name	Name of Thangka Painting	Damage Classification
1	Erdene Zuu Museum	Tselkhanamsum (Longevity Deity)	1.3, 2.1, 3.2, 3.4, 2.3, 3.1, 2.2, 4.3, 3.2, 3.4, 2.6
2000			
2	Erdene Zuu Museum	Demchiggarav Thangka	3.2, 4.3, 2.3, 3.3, 2.6, 3.5, 1.1, 5.3
2001			
3	Erdene Zuu Museum	Bayannamsrai Thangka	3.4, 1.3, 3.5, 1.1, 3.2, 3.4,
4	Erdene Zuu Museum	Six-Armed Mahakala Gombo Thangka	3.4, 4.3, 2.3, 1.3, 1.4, 1.1,
5	Erdene Zuu Museum	Demchiggarav Thangka	1.3, 2.1, 3.4, 3.2, 3.5, 2.4,
2003			
6	Erdene Zuu Museum	Daragshid Thangka	1.1, 1.2, 1.3, 2.6, 3.3, 3.1, 3.2, 4.3, 3.4, 2.1
2004			
7	Erdene Zuu Museum	Shambhala Place Thangka	1.3, 3.2, 3.4, 3.5, 2.1, 2.3, 2.4, 2.6, 4.3,
2005			
8	Erdene Zuu Museum	Sanduin Jud Thangka	1.1, 3.2, 3.4, 2.4, 2.2
9	Erdene Zuu Museum	Gun Sambaa Thangka	3.2, 4.3, 2.6, 1.4, 1.3, 2.4, 3.4, 3.1,
2017			
10	Erdene Zuu Museum	Avid Thangka	1.1, 1.2, 2.6, 2.2, 2.3, 5.3, 5.6, 5.4, 2.4, 5.1, 3.4, 3.1,
2020			
11	Erdene Zuu Museum	Jamsran	4.3, 1.1, 1.2, 1.4, 3.2, 3.4, 1.3, 3.1,
12	Erdene Zuu Museum	Jigjid-Centered Ganzai	1.1, 1.2, 1.4, 3.2, 3.4, 3.6, 1.3, 3.1,

According to the above table, the thangka painting with the least damage is the "Sanduin Jud Thangka" (Figure 2), which shows five individual damages belonging to three damage category. In contrast, the "Avid Thangka" (Figure 3) has the most severe damage, with a total of 12 individual damages belonging to four categories.

RESULTS OF THE DAMAGE ANALYSIS

Based on the results of the damage study, the five categories of damages were arranged in order from highest to lowest occurrence, and the causes of these damages were identified.

Because these environments involve the constant lighting of butter lamps and the burning of incense, the thangkas are often exposed to thick, darkening soot, grease, and smoke that can penetrate deep into the silk brocade and paint, causing severe, often irreversible, damage over time. Since the materials used in thangka paintings include animal and plant-based adhesives, they are vulnerable to pests such as rodents, mice, and insects, which may feed on these materials. Furthermore, if thangka paintings are stored for long periods in humid environment without adequate air circulation, they may absorb moisture and develop mold or fungal growth. When water or other liquids drip or splash onto a thangka painting, it can cause pigment migration, water stains, and the detachment or loss of paint and

ground layers. Fluctuations of relative humidity in the air also affect the structural elements of the thanka. When humidity levels rise or fall, the materials may shrink, contract, expand, or warp, resulting in distortion of the painting's original form. Damage to the ground layer often leads to damage in the paint layer as well. The primary causes of ground layer deterioration are changes in relative humidity and the structural characteristics of thanka paintings, particularly when they are stored rolled up. Long-term storage in a rolled and compressed condition can cause physical damage, such as folding, wrinkling, and deformation of the ground layer.

Second: Paint layer damage was found in 9 out of the 12 paintings, meaning that 75% of the paintings were affected. Paint deterioration occurs due to many factors. In addition to environmental influences and storage conditions (such as air pollution, humidity, temperature, light exposure, and improper storage in museum collections) the deterioration may also result from the raw materials and adhesive components used in the pigments, which gradually lose their quality over time, because paintings stored in the same room under the same environmental conditions exhibit different types of paint damage. Therefore, it is necessary to use the best modern technologies to prevent paint damage.

Third: Damage caused by human activities was found in 7 paintings from 12 paintings, representing 58%. Damage survey shows that this was not an official conservation or restoration intervention (as no reports or documentation exist). Instead, it appears that a non-professional individual carried out restoration on the painting using unsuitable materials and adhesives (a flour-based paste). The study also revealed that no restoration work had been conducted on the thanka paintings of the Erdene Zuu Museum before 1997, and prior conservation activities were limited only to buildings, walls, sculpture exhibits and mural paintings.

Fourth: Damage to the surrounding silk substrate was observed in 2 paintings of these 12 paintings, representing 16%. According to the restoration reports of these 12 paintings included in this study, most of the paintings are missing the silk surrounding them. In regard of damages of two paintings that still had silk surrounding, the silk surrounding had been torn, stained, and the wooden frame broken. These damages are generally caused by aging of the artwork, environmental conditions, and prolonged display while hanging. Since the surrounding silk substrate is an important structural component of a thanka painting, museum staff should pay careful attention to its condition and handle it with appropriate care.

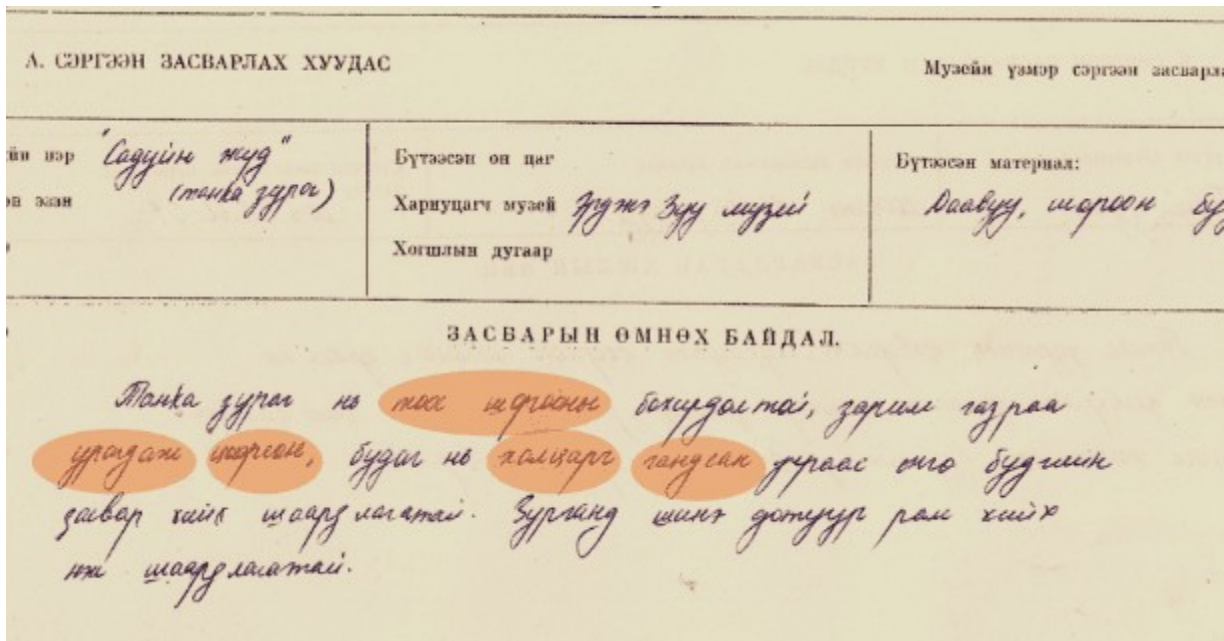


Figure 2. Description of damages recorded in the restoration report of the “Sanduin Jud” Thangka painting

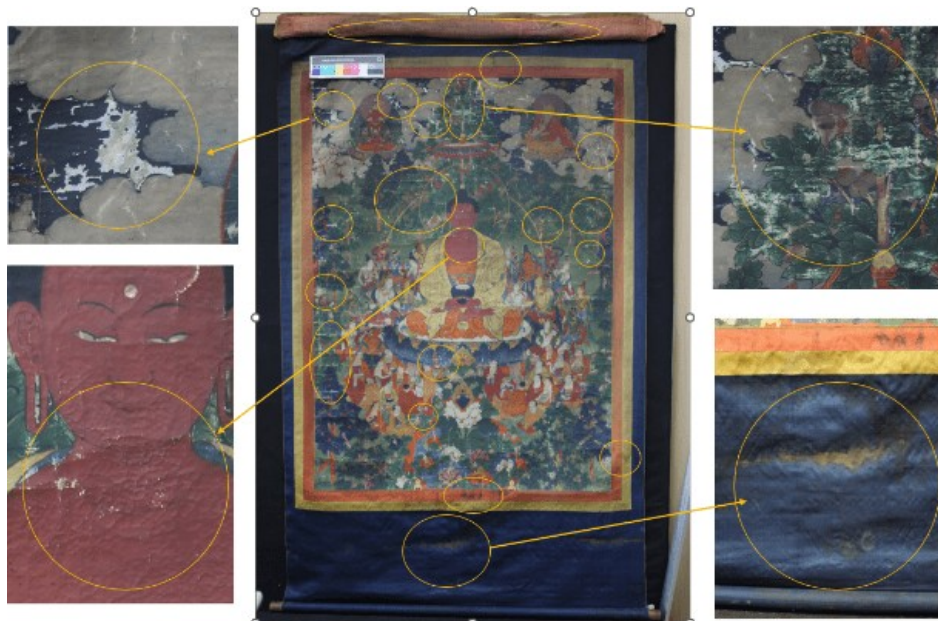


Figure 3. Condition of damage in the “Avid” Thangka painting

Table 4. Percentage of Damage Types (from Highest to Lowest)

Damage type	12 paintings	Damage Percentage
1. Environmental damage	12 paintings	100%
2. Ground layer damage	12 paintings	100%
3. Paint layer damage	9 paintings	75%
4. Human-induced damage	7 paintings	58%
5. Surrounding silk substrate damage	2 paintings	16%

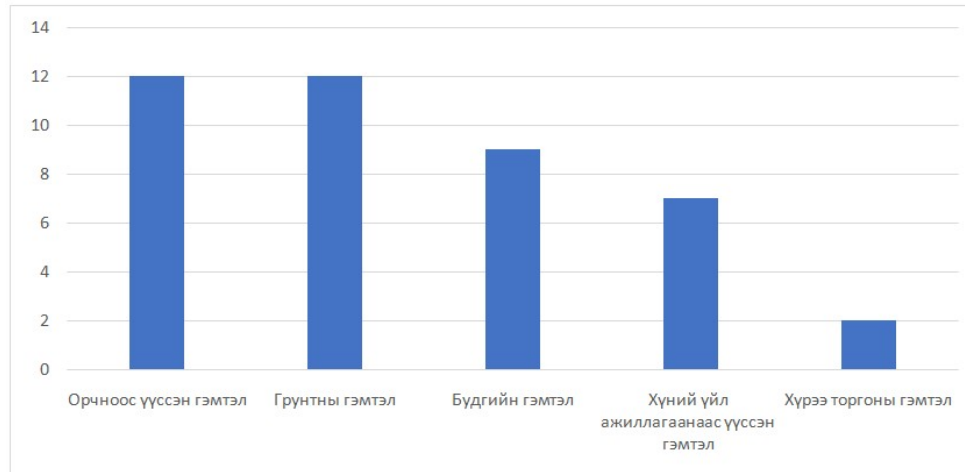


Figure 4. Percentage distribution of damage types observed in thangka paintings from the Erdene Zuu Museum submitted for restoration, arranged from highest to lowest occurrence

Table 5. Condition of damage of Thangka Paintings 5–28 Years after their restoration

#	Year Restored	Name of Painting	Frame	Re-emerged Damage	Number of years Since Restoration up to 2025
1	1997	Shambhala Place	Framed	Color changes observed	28 years
2		Puntsag Gusum's Life Story	Framed	Paint and bronze color changes; paint peeling	
3	1998	Buddha's Life Story	Mounted on board	Adhesive detachment	27 years
4	1999	Chilnamasum (Nasny Buddha)	Framed	Bronze color changed	26 years
5	2000	Demchiggarav	Mounted on a board	None.	25 years
6	2001	Bayannamsrai	Framed, class	None.	24 years
7		Mahagala	Framed	None.	
8	2002	Khasarvaani Janraisig	Mounted on board.	None	23 years
9		Buddha's 12 Zokhiongvi Thangka	Framed	Paint and bronze color changes.	
10		Demchog	Silk	The inscriptions of the deities' names were painted over during the restoration	
11	2003	Daragshid	Mounted on board.	None	22 years
12		Gongor	Framed	None	
13		Chadraabal	Framed	None	
14		Damdin Jalbaa with Zaminduud	Mounted on board.	None	
15	2005	Sanduin Jud	Mounted on board.	None	20 years
16		Gun Samba	Mounted on board.	None	
17	2017	Avid	With silk	Paint flaking and peeling	8 years
18	2020	Jigid Golloson Ganzai	Mounted on board.	None	5 years
19	Exact date of restoration is unknown	Ganzai	Mounted on board.	None	Unknown
20		Divangar	Framed	Paint flaking, peeling, color changes.	
21		OchirdariGolloson Duvchinjalbuu 81 shid	Mounted on board.	None	
22		Baldanlkhram	Mounted on board.	Paint flaking and peeling	
23		Maidar	Framed	None	
24		15 separate miracles of Buddha	Framed	None	

Observations based on the results of restoration of Thangka Paintings at Erdene Zuu Museum: A survey was conducted from August 23-27, 2025 by the researcher to examine the current condition of 31 thangka paintings restored between 1997 and 2020. A total of 24 paintings were observed (Table 5). Some thangka paintings had been moved for exhibition. The methods and techniques of conservation for tangible cultural heritage have been evolving over time, depending on scientific developments, technological advances,

and contemporary restoration practices. This study aimed to evaluate the suitability of restoration techniques, methods, and materials used at the time of restoration for their long-term effectiveness and stability.

Summary of survey of damages in the restored Thangka Paintings: A survey of damages in restored Thangka paintings reveals that despite conservation efforts, these paintings often suffer

from ongoing degradation due to their hygroscopic nature, environmental factors, and previous, often well-intentioned but improper, restoration attempts. Common damages include color changes (fading or darkening), structural deformation, and material failure. As shown the Table 5 there are 22 paintings, framed or mounted on board; two paintings with silk mountings; five paintings with color changes; 4 paintings with paint flaking and peeling; 1 painting with adhesive detachment; 1 painting with restoration technique errors; and 15 paintings without any visible damage. The survey we conducted revealed that no documentation or restoration reports for six paintings numbered 19–24 restored from the Erdene Zuu Museum or the National Center for Cultural Heritage. Judging by the restoration method, the materials used, and the ways they are glued to the board it can be assumed that they were restored during 1997 to 2005. Therefore, a total of 37 paintings included in the study by adding these 6 paintings to the documented 31 paintings.

Analysis of causes of damage: Color changes in the five paintings occurred because the original paint and the restoration paint had different raw material compositions, leading to changes in color over time. The damage described— paint flaking and peeling in the four paintings, including the “Avid” thankha, which is mounted on silk – is a common consequence of improper handling, specifically rolling and unrolling canvas or silk scroll paintings. Other paintings, even if mounted on board or framed, also showed some flaking or color loss, due to incompatibility of original and restoration adhesives or aging of the adhesives and unsuitable storage conditions. Adhesive detachment in one painting resulted from deterioration of the original mounting adhesive over time. In one painting, where there was an error in the restoration methodology, the researcher and owner of the painting raise a concern that the Tibetan inscription on the painting was overwritten.

Regardless of whether it was a restorer's mistake or the inscription on the painting may have been removed before the painting was initially submitted for restoration, this issue highlights the need for professional ethics and careful adherence to conservation principles in future restoration projects. Examples of damages observed throughout field survey in thankha paintings restored between 1997 and 2020 presented below. There are four paintings showing discoloration of paint. This damage occurred after restoration of paintings. Discoloration of paint after restoration is a common issue in conservation, often resulting from chemical reactions between original pigments, or the deterioration of old layers. The use of different raw materials in restoration paint compared to the original artwork is a major factor in subsequent, uneven color changes over time. There are four paintings showing discoloration of paint. This damage occurred after restoration of paintings. Discoloration of paint after restoration is a common issue in conservation, often resulting from chemical reactions between original pigments, or the deterioration of old layers. The use of different raw materials in restoration paint compared to the original artwork is a major factor in subsequent, uneven color changes over time

Materials used in restoration: The methods, types of paint, adhesives, and materials used were identified from the restoration reports of 12 thankha paintings with above damages. The original ground of the paintings was restored using a modern chalk-based gesso, mixed with unspecified adhesives. (Tselkhenamsum 1997, Bayannamsrai 2001, Six-Armed Mahakala Gombo Thangka 2001, Demchiggarav 2001, Daragshid 2003, Shambalyn Oron 2004, “Gunsambaa” 2005). 3% Paraloid used for paint strengthening (Tselkhenamsum 1997, Bayannamsrai 2001, Demchiggarav 2001, Daragshid 2003, Shambalyn Oron 2004). The name and manufacturer of paint used for restoration are unknown (Tselkhenamsum 1997,



Baldanlkham



Divangar



Avidyn Shangad

Figure 5. Paint Flaking and Peeling



In Shambhala Place



The 12 Buddha's teachings



Divangar



Chilkhanamsum

Figure 6. Discoloration of Paint

Demchigarav 2000, Bayannamsrai 2001, Six-Armed Mahakala Gombo 2001, Demchigarav 2001, Daragshid 2003, Shambalyn Oron 2004, Sanduin Jud 2005, “Gunsambaa” 2005). Golden areas in the thangkas were restored using bronze. (Demchigarav 2000). Torn areas were patched with fabric, but the type of adhesive used is unknown. (Bayannamsrai 2001, Six-Armed Mahakala Gombo 2001, Demchigarav 2001).



Buddha's Life Story

Figure 7. Detachment of adhesive in patches

Dirt from insects and animals was mechanically cleaned, though the tools used are unspecified. (Six-Armed Mahakala Gombo 2001, Shambalyn Oron 2004, Gunsambaa 2005). Also it is not clearly identified what materials and adhesives used to fill holes in the painting (Sanduin Jud 2005) The “Shambalyn Oron” painting was restored in 2004 using methylcellulose, animal glue, and wallpaper glue, and mounted on a wooden panel. The “Gunsambaa” painting was restored in 2005, and the torn areas of this painting patched 100% using cloth, attached and reinforced using wallpaper glue and a dubbing adhesive made from polyacetone (P.O.W).. Paint strengthening was done with 3% Paraloid solution (xylol, dimethyl, benzoline). The painting was also mounted on a wooden panel using Polyacetone vinyl and jute.

В. СЭРГИЙН ЗАСВАРЛАГААН ХҮҮДАС		
Үндэстний сүргийн засварлагч	Сүргийн засварлагчийн хувиараа	Сүргийн засварлагчийн баримтын зураг
С. Батжаргал	2005 оны 07 сарын 15 өдөр	
ЗАСВАРЛАГААН АЖЛАХЫН ЯВЦ		
<ol style="list-style-type: none"> 1. Сүргийн өвчлөлтийг урьдчилан сэргийлэх, урьдчилсан дотоо зургийг авч... 2. Сүргийн бүхэлд нь хатуу элсний хэсгийг хөндөж, хатуу элсийг урьдчилан... 3. Сүргийн урьд нь хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 4. Сүргийн дотоо хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 5. Сүргийн дотоо хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 6. Сүргийн дотоо хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 7. Сүргийн дотоо хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 8. Сүргийн дотоо хатуу элсийг хөндөж, хатуу элсийг урьдчилан... 		

Figure 8. The materials used in restoration of “Gunsambaa” painting are highlighted from the restoration report

The “Avid” painting was restored in 2017. The solvent composed of 50% C_3H_7OH (isopropanol) and 50% C_8H_{10} (xylene or ethylbenzene) used in painting conservation for removing tough dirt and varnishes. Rembrandt watercolor paint and MARIE’S gouache used for paint restoration and 1.5% Paraloid V.72 and CH_3OOCH_3 used for paint strengthening. Surrounding silk areas were restored with thread, and broken wooden parts were replaced. “Jamsran” and “Jigjid Golloson Ganzai” paintings were restored in 2020; dirt cleaned with 50% C_3H_7OH and 50% C_8H_{10} ; contamination from insect feces mechanically cleaned with a surgical knife (scalpel), and punctured or torn areas patched using scrap paper papyrus and white glue (rice glue). Gessowith chalk and animal glue used for restoration of painting primer; 1.5% Paraloid V.72 and CH_3OOCH_3 used for paint strengthening; Rembrandt watercolor paint and MARIE’S gouache used for restoration of painting's color. The painting mounted on wooden panel using animal, white, and paste glues. Observations of methods and materials used in the restoration of the tanka paintings

above, we can see that the methods and materials used in the restoration in period of 1997-2005 and 2017-2020 are different. Comparing these to other museum thangka restoration reports we can assume that restoration methods for thangka paintings can be divided into two phases as the “Development Phase” (1988–2010) and the “Progress Phase” (Since 2011). As mentioned above, the evolution of tangible cultural heritage restoration techniques is fundamentally driven by ongoing scientific knowledge, technological progress, and material advancements.

CONCLUSION

In this study we conducted the survey aimed to provide registration data of thangka paintings from the Erdene Zuu Museum of Kharkhorinsoum, Uvurkhangai Aimag restored at the National Center for Cultural Heritage between 1988 and 2022 and to represent a quantitative evidence of thangka paintings restored during specific years, identify which conservators carried out the restorations, and analyze the methods and materials they used; and determine whether those restoration methodologies and techniques remain appropriate up to the present time. A total of 37 thangka paintings were restored between 1988 and 2020, of these, the damages of 12 paintings having sufficient documentation for analyses and could be included in damage survey at the time they were submitted for restoration, were classified into five main categories comprising 30 individual types. Thus we created a basic classification for identifying the causes and conditions of damages of heritage of this type and other types with similar nature. Accurately identifying the type of damage is the cornerstone of effective preservation, protection, and restoration, serving as a critical first step that directly impacts the long-term survival of cultural heritage. Among the five types of damage, “Environmental Damage” and “Ground Damage” were most frequent and are likely to continue occurring in museum collections. Therefore, items with these damages should be prioritized for preservation and restoration by museum management and restoration organizations. The discoloration in five restored paintings is due to differences in the raw materials of original and restoration paints. As observed in 4 paintings with paint flaking and peeling damage, for example in the “Avid” painting on silk, this type damage usually occurred as a common consequence of rolling and unrolling of silk. Other mounted or framed paintings also showed paint flaking, likely due to unsuitable composition of the paints and adhesives or long-term degradation of adhesives in unsuitable conditions. For one painting in which an error occurred in the restoration methodology, the researcher and the owner of the painting raised a concern that the Tibetan inscription on the painting had been covered over with paint. Regardless of whether it was a restorer's mistake or inscription on the painting was damaged before the painting submitted for restoration, this issue highlights the need for professional ethics and careful adherence to conservation principles in future restoration projects. This study identifies and clarifies the types of damage as well as the restoration methods and techniques applied to the above-mentioned thangka paintings, which is of significant importance for conservation and restoration work. In the future, it will also contribute as part of the fundamental scientific research on the preservation and protection of tangible cultural heritage.

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