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Management of Occurring Threats to Wooden Monasteries in Mandalay: A Case Study of Maha-Minhtin Monastery

မန္တလေးမြို့ရှိသစ်သားဘုန်းကြီးကျောင်းများ ကြုံတွေ့နေရသည့် ဘေးအန္တရာယ်များကိုစီမံခန့်ခွဲခြင်း- မဟာမင်းထင်ဘုန်းကြီးကျောင်း ကို လေ့လာခြင်း

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Abstract

Pyu ancient cities and Bagan are recognized as World Heritage Sites in Myanmar. Likewise, Mandalay is on one of the tentative lists under the name of Ancient Cities of Upper Myanmar: Innwa, Amarapura, Sagaing, Mingun, and Mandalay, submitted in 1996. As Mandalay is the cultural capital of Myanmar, many intangible and tangible cultural heritage from different times (the late Konbaung, the colonial era and the pre-independence era, etc.) remain. It is striving to become a world heritage site by means of these factors. Out of the tangible heritage structures, most are religious buildings (stupas, temples, monasteries, churches, mosques, Hindu temples, etc.). Almost all of these buildings are still in use by way of their original functions and are being maintained by the relevant authorities to the best of their ability. Additionally, these buildings were made of weather-resistant materials such as brick and stone, so they still exist intact to this day. However, amid all of them, the late Konbaung period wooden monasteries face grievingly confronting devastations. For the wooden monasteries are almost a hundred years old and have been impaired by many natural disasters. They have been encountering disturbing threats owing to the decay of wood, the scarcity of quality wood for replacement, and poor maintenance techniques. Systematic management for the long-term existence of the wooden monasteries of the late Konbaung era, in the Unesco World Heritage tentative site of Mandalay is important. Therefore, in this research paper, the case study of a monastery facing the worst possible situation is identified and described followed by a discussion on the ways to prevent these hazards and locally appropriate maintenance recommendations will be looked for and presented. A lot of research that is associated with the architecture of wooden monasteries in Mandalay, histories and the wood has been done by various local and foreign professionals. However, this research aims to fill this gap, as the reasons for the deterioration of these wooden monasteries, challenging threats, and experiencing facts to be long-lasting have not been systematically researched yet.

မြန်မာနိုင်ငံတွင် ရှေးဟောင်းပျူမြို့များနှင့် ပုဂံသည် ကမ္ဘာ့အမွေအနှစ်ဒေသများအဖြစ်သတ်မှတ်ခံထားရသည့် မြို့များဖြစ်သည်။ ၎င်းတို့နည်းတူမန္တလေးမြို့သည်လည်း ရှေးဟောင်းမြို့များဖြစ်သည့် အင်းဝ၊ အမရပူရ၊ စစ်ကိုင်း၊ မင်းကွန်းမြို့တို့နှင့်အတူ ကမ္ဘာ့အမွေအနှစ်ဒေသတခုဖြစ်ရန် ၁၉၉၆ ခုနှစ်ကပင် လျာထားကြိုးပမ်း ဆောင်ရွက်နေသည့် ဒေသတခုဖြစ်သည်။ မန္တလေးမြို့သည် မြန်မာနိုင်ငံ၏ယဉ်ကျေးမှုမြို့တော် ဖြစ်သည်နှင့်အညီ ကုန်းဘောင်ခေတ်နှောင်း (ရတနာပုံခေတ်)၊ ကိုလိုနီခေတ်၊ လွတ်လပ်ရေးအကြိုခေတ်စသဖြင့် ခေတ်အဆက်ဆက်က ရှိခဲ့သော ဒြပ်ရှိ ဒြပ်မဲ့ယဉ်ကျေးမှု အမွေအနှစ်များများစွာကျန်ရှိနေသေးသည်။ ထိုအချင်းအရာ များကို အားပြု၍ ကမ္ဘာ့အမွေအနှစ်နေရာတခုဖြစ်ရန် ကြိုးပမ်း ဆောင်ရွက်လျက်ရှိသည်။ ဒြပ်ရှိအမွေအနှစ်များထဲတွင် ဘာသာရေး နှင့် ဆိုင်သော အဆောက်အဦများ (စေတီ၊ ပုထိုး၊ ဘုန်းကြီးကျောင်း၊ ခရစ်ယာန်ဘုရားရှိခိုးကျောင်း၊ ဗလီ၊ ဟိန္ဒူဘုရားကျောင်းစသဖြင့်) မှာအများဆုံးဖြစ်သည်။ ထိုအဆောက်အဦးအားလုံးနီးပါးမှာ ယခုအချိန်ထိ ၎င်းတို့၏မူလရည်ရွယ်ထားသည့် အတိုင်းအသုံးပြုလျက်ရှိပြီး သက်ဆိုင်ရာ တာဝန်ရှိအဖွဲ့အစည်းများမှ မူလလက်ရာမပျက်အောင်အတတ် နိုင်ဆုံး ထိန်းသိမ်းစောင့်ရှောက်ထားကြသည်။ ထို့အပြင် ၎င်းအဆောက်အဦးများကို အုတ်၊ ကျောက် စသည့် ရာသီဥတုဒဏ် ခံနိုင်ရည်ရှိသည့် ပစ္စည်းများဖြင့် တည်ဆောက်ထားသဖြင့် ယနေ့ထက်တိုင်ကောင်းစွာ တည်ရှိနေကြသည်။ သို့သော် ၎င်းတို့ထဲ တွင် ကုန်းဘောင်ခေတ်နှောင်းသစ်သားဘုန်းကြီးကျောင်းများမှာ ဝမ်းနည်းစရာကောင်းစွာပင် ပျက်စီးမှုများစွာဖြင့်ရင်ဆိုင်နေရသည်။ သစ်သားဘုန်းကြီးကျောင်းများသက်တမ်းမှာ နှစ်တရာနီးပါးရှိပြီဖြစ်သောကြောင့်သဘာဝ ဘေးဒဏ်အများအပြား ရိုက်ခတ်ခံခဲ့ရသဖြင့် အသုံးပြုထားသောသစ်သားများဆွေးမြေ့ပျက်စီးလာခြင်း၊ အစားထိုး ပြုပြင်ရန် အရည်အသွေးစံချိန်မီ သစ်သားရှားပါးလာခြင်းနှင့် ပြုပြင်ထိန်းသိမ်းမှုအားနည်းခြင်းတို့ကြောင့် စိုးရိမ်ဖွယ် အန္တရာယ်များပိုမိုကြုံတွေ့နေရသည်။ အမွေအနှစ်ဝင်ရန်လျာထားနေရာ တခုဖြစ်သည့် မန္တလေးမြို့ရှိကုန်းဘောင်ခေတ်နှောင်း၏လက္ခဏာတခုဖြစ်သော သစ်သားဘုန်းကြီးကျောင်းများ ရေရှည်တည်တံ့စေရေးအတွက် ထိန်းသိမ်း စောင့်ရှောက်ရန်မှာ အရေးပါ သည့် အခန်းကဏ္ဍတခုပင်ဖြစ်သည်။ ထို့ကြောင့် ဤသုတေသနတွင် သစ်သားဘုန်းကြီးကျောင်း များကြုံတွေ့နေရသည့် အန္တရာယ်များကို ပျက်စီးမှုအဆိုးဆုံးအခြေအနေရှိနေသည့် ဘုန်းကြီးကျောင်းတကျောင်းကို နမူနာ အဖြစ်လေ့လာခြင်း၊ ၎င်းအန္တရာယ်များ မှတားဆီးကာကွယ်ရန်နည်းလမ်းများနှင့် နေရာဒေသနှင့်ကိုက်ညီမည့် ပြုပြင်ထိန်းသိမ်းမှုဆိုင်ရာ အကြံပြုချက်များကို ရှာဖွေတင်ပြသွားမည်ဖြစ်ပါသည်။ မန္တလေးရှိသစ်သားဘုန်းကြီးကျောင်းများ၏ ဗိသုကာလက်ရာများ၊ သမိုင်းကြောင်းများ နှင့် သစ်သားနှင့် ပတ်သက်သည့် သုတေသနများစွာကိုပြည်တွင်းပြည်ပ ပညာရှင် အသီးသီးမှ ပြုလုပ်ခဲ့ပြီးဖြစ်သည်။ သို့သော် ဤသစ်သားကျောင်း များ ပျက်စီးလာသည့် အကြောင်းရင်းများ၊ ရင်ဆိုင်နေရသည့်အန္တရာယ်များ နှင့် ရည်ရွယ်ရပ်တည်ရန် ကြုံတွေ့နေရသည့် အချက်များကို စနစ်တကျ သုတေသနပြုလုပ်ထားခြင်းမရှိသေးသည့်အတွက် ထိုလစ်ဟာမှုကို ဖြည့်ဆည်းပေးရန် ဤ သုတေသနက ရည်ရွယ်ပါသည်။

Keywords: Mandalay, Tentative list, Late Konbaung wooden monasteries, Threats, Maintenance | မန္တလေး၊ လျာထားစာရင်း၊ ကုန်းဘောင်ခေတ်နှောင်းသစ်သားဘုန်းကြီးကျောင်းများ၊ အန္တရာယ်များ၊ ပြုပြင်ထိန်းသိမ်းမှု

Introduction to Late Konbaung Wooden Monasteries in Mandalay

The great King Mindon shifted to and ruled from Yadanabon, a royal city (Mandalay) in 1857 (Myanmar year 1221) in the north of Amarapura, where the former throne was located. Members of the royal family moved their palatial apartments from Amarapura to Mandalay. When they arrived in Mandalay, those apartments were renovated with wooden adornments and roof designs that were suitable to the characteristics of the monastery and donated as monasteries. King Mindon placed the monasteries on the east, west, north, and south sides based on the palace where he lived (Nat Maut

Tun Shein 2009). Since then, there were many late Konbaung-era wooden monasteries in Mandalay that were donated until the loss of independence. Compared to the architectural masterpieces of the monasteries that have been built from time to time, the monastic architecture of the late Konbaung era is the most magnificent. During World War II, many wooden monasteries were bombed and destroyed by fire. The remaining monasteries have been suffering from weather and other disasters for many years, and today their condition is deteriorating on all sides. Timely management of these situations should be prioritized. It is necessary to know the current situation of the wooden monasteries and their original nature to be performed for the management of them. As regards the study of original nature, the wooden monasteries were built of high-quality teak at that time. The buildings are positioned along the east-west axis. They are stilt type and composed of four apartments. They are a shrine apartment, a *sanu* apartment (connector or living apartment), a main apartment, and a store apartment. The shrine apartment is placed on the east side, which is the highest place of the Burmese people. Adjacent to the shrine apartment, there is a *sanu* apartment. That is for the head monk of the monastery and is a space for reading and resting. This apartment is covered with the levels of roof called a sanu-yoon-khaung in Burmese. The main apartment, the largest part of the monastery is behind it. It is roofed with a three or five-storeyed roof called zay-ta-wun-khaung. It is also called zay-ta-wun apartment depending on the name of the roof. This is divided by a wooden partition in the middle. This wooden partition is called marabin in Burmese. With reference to this, this apartment is also known as the marabin hall. There is a statue of Buddha on the east side of the main apartment. It is used to meet the guests, to give the five virtues and to study for young monks and students. The back of the wooden partition is the private room of the young monks. There is a corridor at the back of this room and a storage apartment next to it. The materials used by the monks to go out for alms and long-lasting food are placed in it, and at times the young novices often live there. The apartment mentioned above is surrounded by a wide veranda and is accessed from the ground by eight brick staircases (Myo Myint Sein et al. 1970). The space composition of the late Konbaung wooden monastery and the location of the brick staircases are shown in the following typical plan.

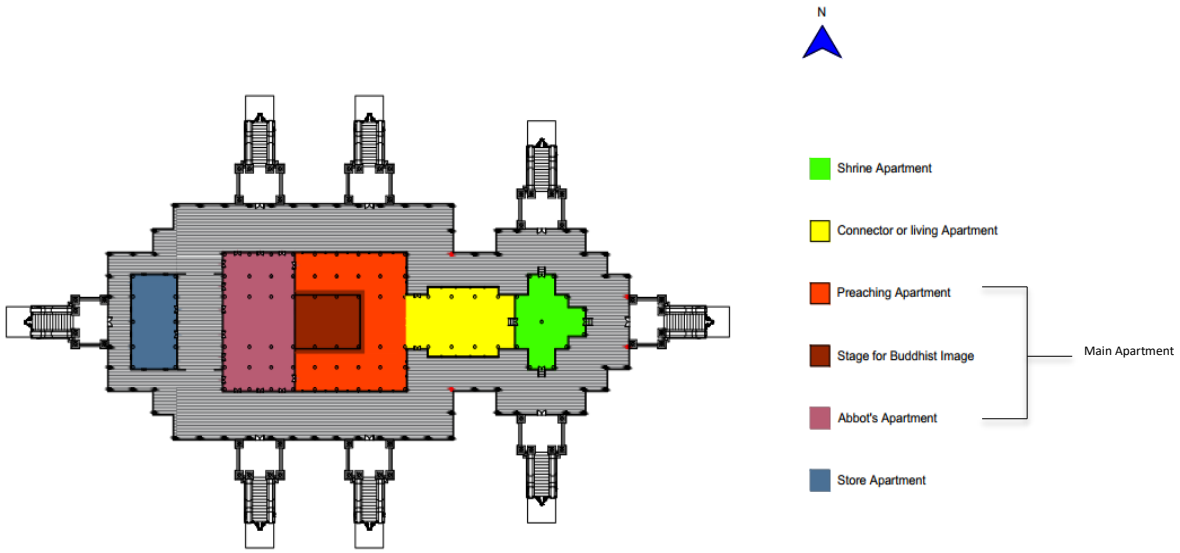

Fig. 1 Typical plan of late Koabung wooden monastery. Source: Drawn by author, 2020.

Although the spatial composition of the late Konbaung monasteries was generally as described above, the ornamentation of the monasteries differed depending on the status of the donor. In such discrimination, the most obvious visual difference is the veranda handrails. The handrail of the monastery, donated by the king and chief queen is fully made of exquisite carvings on the wooden

planks. An example of that is the handrail design of the Shwe Nan Daw Kyaung (Golden monastery), the meritorious deed of King Mindon.

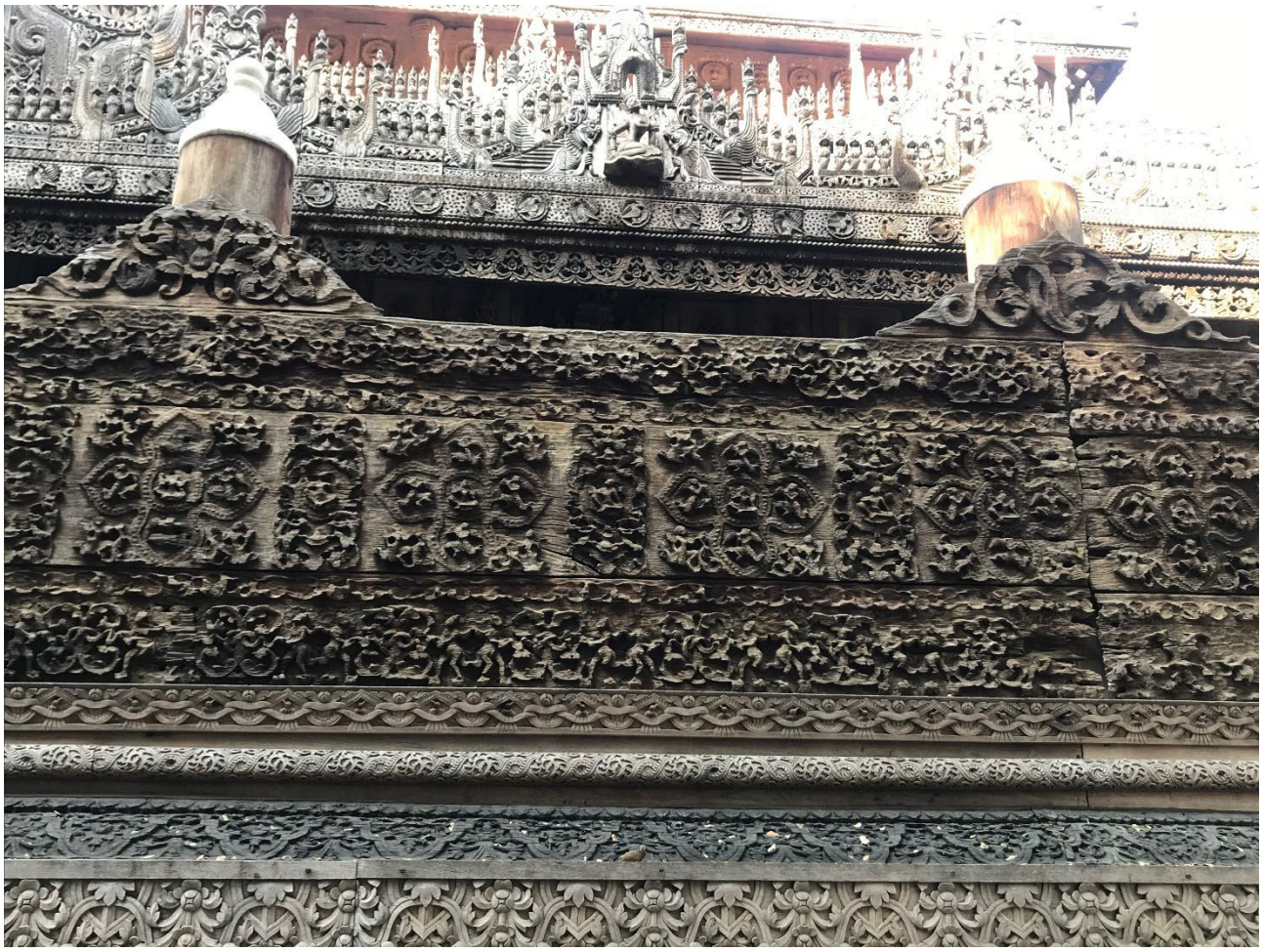

Fig. 2 Handrail design of Shwe Nan Daw Kyaung. Source: Photo by author, 2021

The handrail design of the veranda including in the monasteries, donated by government officials and the rich, is decorated with wooden objects and is adorned with wooden planks made of carved wooden figures on the top and bottom of the object. The differences between these sidewalk handrails are illustrated below[1].

[1] Discussion with U Pauk Pauk who is a retired deputy director, Department of Archaeology and Museum, Mandalay and U Win Maung (Tanpawaddy), a well-known traditional architect and archaeologist.

Fig. 3 Handrail design of Kyay-myin Monastery. Source: Photo by author, 2021.

Late Konbaung wooden monasteries were not only sacred places for religion, but also the educational center of the time. Monasteries are decorated with wooden sculpture depicting the Buddha's past life stories including in the five hundred and fifty Jatakas. In view of this, the late Konbaung wooden monasteries were not only the ones for people but also existed as a library described with adornments (Maung Yin Hlaing 2008). These wooden monasteries, which reflect the religion of the time, culture, and way of life, are coming to be destroyed on account of various disasters. In addition, they have disappeared from the public eye and come to be forgotten with advancing material development. Their current situation will continually be studied as follows.

Research Methodology

The authors recorded the current situation of all 14 of the late Konbaung wooden monasteries in Mandalay in the research methodology as the first step of this research. Out of them, the monastery with the poorest physical condition was selected to study in detail. The authors interviewed the staff of the Ministry of Religious Affairs and Culture (MORAC) related with maintenance works of wooden monasteries, architects, and archaeologists, and collected the respective references for secondary data. There are two main components in this paper. In the first component, the study and analysis of the past and current condition of selected monastery were described. In this step, we used the descriptive and analytical methods. As the next step, we explored the occurring threats, challenges, solutions, and management working process of wooden monastery.

Current Condition of Wooden Monasteries

According to historical records and literature, there were more than 50 wooden monasteries built and donated in Mandalay in the 18th and 19th centuries. However, remaining wooden monasteries hit only one-fourth of that quantity. The rest of wooden monasteries are classified into three types as follows:

Type I
The first type was built as a monastery from the beginning. They were built only as the monastic architecture of the Konbaung era. When one studies the monastic architecture of the Konbaung era, these buildings must be chosen.

Type II
These monasteries were built in western architectural styles, using not only wood but also incorporating brick and masonry. However, this paper will study only the wooden monasteries of the Konbaung era, so brick architectural monasteries will not be included in this paper.

Type III
Type III's monasteries were not originally used as monasteries. They were the apartments of royal the family. For instance, during the reign of King Mindon, the royal palace was relocated from Amarapura to Mandalay. At that time, the royal families donated their royal apartments to the monks for use as monasteries. In the transformation of their apartments into a monastery, the space composition, the shape of the roof, the design of the handrails, and the staircases were transformed in accordance with the characteristics of a monastery. A significant example of this Type III is the Shwe Nan Daw Kyaung which was the royal apartment of King Mindon. It was donated to the monk whom King Mindon worshiped, by King Thibaw, son of King Mindon, the last king of the Konbaung era.

These three types of monasteries are not only historically important buildings but also architecturally irreplaceable ones. But, as the years go by, these buildings come to face damage and ruin on account of natural disasters and man-made disasters. In addition, they gradually disappeared from public view and become forgotten issues owing to urban and material development. Therefore, it is very important to preserve their original form as much as possible, and to raise public awareness about them. The table below outlines the names and information about the wooden monasteries remaining in Mandalay:

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Name and Type	Year Built	Current Architectural Condition	Current Physical Condition	Status
Shwe Nan Daw Kyaung Monastery ရွှေနန်းတော်ကျောင်း (Type III)	1878-83	Excellent The architecture of this monastery is excellent as it was the donation of the king. The wooden artwork was also delicate, scrupulous, and astonishing. However, it was frequently repaired and maintained as the life span of the building is over 100 years old and has suffered damage from natural and man-made threats. At present, MORAC and World Monuments Fund (WMF) are collaborating on systematic maintenance to prevent the value of the building from decreasing. The work procedures of maintenance of it have been studied as the literature review in the next article.	Good (Under conservation works by WMF and MORAC)	Museum
Shwe Kyin Monastery ရွှေကျင်ကျောင်း (Type I)	1860	Good This was donated by King Mindon. The original architecture is sophisticated. However, there is damage because of the building's long life. At present, about 80% of the building has been repaired. Modern methods have also been used to thoroughly verify the wooden properties that will be used and to prevent wood contractions. The wooden artwork has also made in the same way as the original works, so its architectural value is in a decent position, not much lower than the original work.	Good (Under maintenance works by Thai monks and MORAC)	Monastery
Shwe Inbin Monastery ရွှေအင်ပင်ကျောင်း (Type I)	1895	Good Shwe Inbin monastery was donated by a rich Chinese man, U Set Shwin. It is one of the best examples of wooden architecture monasteries. Its spatial composition is different from other monasteries. Although some of the original wooden sculptures decorated in the building are degenerating, the abbot is systematically maintaining the monastery's original works so that they don't decay anymore.	Good (Maintained by monks)	Monastery

Bamaw Monastery ဗန်းမော်ကျောင်း (Type I)	1820	Moderate A donation of Queen Bamaw. More than half of the monastery has been restored at present. Although the building has been maintained as the original design, wooden sculptures which are decorated elements have not been preserved resulting in much damage and loss.	Good (Maintained by MORAC)	Monastery
Yamaethin Monastery ရမည်းသင်းကျောင်း (Type III)	1870	Good Queen Yamethin donated her apartment to be used as the Yamethin monastery when she moved from Amarapura to Mandalay. It is a monastery with many astonishing Amarapura-era original works of glass mosaic and wooden sculptures. It is an architecturally valuable building constructed with a unique roof design, spatial composition, and decorative elements. The original building design is stilt-type, but these days some brick walls are added on the ground floor in order to improve the structural strength, resulting in a reduced exterior architectural value.	Moderate (Maintained by residential monks)	Monastery
Mogaung Monastery မိုးကောင်းကျောင်း (Type III)	1871-75	Good When she moved from Amarapura to Mandalay, Queen Mogaung donated her apartment as a monastery. Although much of the original architecture has remained, being repaired with new materials that are not suitable for the original design of the building results in decline in architectural value.	Moderate (Maintained by residential monks)	Monastery
Kyay-myin Monastery ကြေးမြင်ကျောင်း (Type III)	1875	Good Queen Kyay-myin donated her apartment as a monastery by the time she moved from Amarapura to Mandalay. It is an architecturally valuable building like Yamethin and Mogaung monastery. Despite many of the original works remaining, the ground floor was surrounded by wood partitions like the Yamethin monastery resulting in a reduced original architectural value.	Moderate (Maintained by residential monks)	Monastery

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Pyay Min Thar Monastery ပြည်မင်းသားကျောင်း (Type I)	1839	Good Pyay Min Thar monastery, a stunning architectural example, was a donation of Pyay Minthagyi (Prince Pyay). Although many of the original features remain, the veranda at the south of the shrine apartment has disintegrated. However, brick walls were added to support the structural strength of the building on the ground floor beneath the shrine apartment and used as rooms for monks. In addition to using inappropriate material, it is a design that interferes with its original stilt type. That is why the original architectural value has decreased.	Moderate (Maintained by residential monks)	Monastery
Tha-ka-wun Monastery သာကဝန်ကျောင်း (Type II)	1879	Good It is the only western style wooden monastery in Mandalay. Although there is an oral history that Kin Wun Min Gyi U Kaung built and intended it as his house, there is no solid evidence. Many outstanding original architectural features remain, but also there is much damage.	Moderate (Maintained by residential monks)	Monastery
Pinthar Min Thar Monastery ပင်းသာမင်းသားကျောင်း (Type III)	1878-1885	Poor It is the donation of Prince Pinthar. Although the building does not have many decorative elements, it has excellent spatial composition and construction techniques. At present, however, due to using new incompatible materials with the building during renovation, and lack of systematic maintenance, the original symptoms have gradually faded, and the original architectural value is declining.	Moderate (Maintained by residential monks)	Monastery
Thingazar Monastery သဂ်ီးကျောင်း (Type I)	1861	Moderate It is the royal donation of King Mindon. Although it is an architectural masterpiece of the Konbaung era donated with magnificent wooden sculpture, its aesthetic value appears low because of newly built pillars and destruction.	Moderate (Maintained by MORAC)	Monastery

Maha-Minhtin Monastery မဟာမင်းထင်ကျောင်း (Type I)	1878	Moderate Although a great deal of original features remains, there is many damages incurred in a short time due to a complete lack of maintenance. Appropriate maintenance should be performed in time, or this high-value architecture will be in danger.	Poor (Maintained by MORAC)	Monastery
See-daw-myin-wun Monastery စီးတော်မြင်းဝန်ကျောင်း (Type I)	1847	Poor Unlike the other monasteries of the Konbaung era, these two monasteries were built with a simple design without significant wooden architecture. It is found only with simple space composition and roof style.	Poor (Under conservation works by residential monks and MORAC)	Monastery
Sar-daw-wun-min Monastery စားတော်ဝန်မင်းကျောင်း (Type I)	1878-1885		Poor (Under conservation works by residential monks and MORAC)	Monastery

Table 1 List of late Konbaung wooden monasteries with their value indications and current situation. Information gathered from interviews with MORAC staff, U Win Maung and U Pauk Pauk in 2021.

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Of the fourteen monasteries listed, the detail of the current situation of Maha-Minhtin monastery, which is more vulnerable to threats, will be discussed as a case study along with a proposed management plan. Before studying and analyzing the current situation of Maha-Minhtin monastery, the conservation work procedures of Shwe Nan Daw Kyaung monastery will be discussed as a comparison.

Conservation Works of Shwe Nan Daw Kyaung

Shwe Nan Daw Kyaung conservation works have been conducted by MORAC and WMF since 2014. In making such maintenance, international and local experts systematically organized assessments in various sectors. According to these assessments, the primary cause of Shwe Nan Daw Kyaung damage is poor drainage management. The cause of previous and ongoing threats is also due to flooding. The maintenance plan is divided into two sections to solve these problems.

Section 1

1. Veranda maintenance
2. Separating damaged wooden posts by level, repairing, and replacing them
3. Hardening wooden posts and repairing the floor
4. Examining and finding ways to maintain the Naya decorations on the wooden posts according to the original records
5. Maintaining the remaining wood arts
6. Restoration of lost historical components
7. Placing waterproof and non-rustin covers under the marble covers of the veranda posts
8. Replacing the Konbaung era nails used in the building with modern nails
9. Insect hazard suppression
10. Architectural details drawing and photography recording
11. Retaining five staircases
12. Repairing roofs

Section 2

1. Solving drainage system
2. Demolition of concrete bracing built in a previous maintenance
3. Improving ventilation of the soil under the floor
4. Completing the walkway under the veranda
5. The preservation of the sein taung (အုတ်စိန်တောင်) at the bottom of the building.

In the working procedures mentioned above, the techniques of the Konbaung era have been observed, studied, and revised to prevent the decline in ancient architectural values and construction technique values (Department of Archaeology and Museum 2017). After studying the working process of Shwe Nan Daw Kyaung, the detail examining of Maha-Minhtin monastery will be stated below (Department of Archaeology and Museum 2018).

History of Maha-Minhtin Monastery and its Previous Maintenance Works

The original location of Maha-Minhtin monastery is Innwa city and it was built in 1852 (Burmese year 1214). In 1876, the son of the original monastery donor, Sin Wun Min Hla Min Htin, relocated the monastery to Mandalay and rebuilt it. The monastery was very big, and so construction was completed in 1878. The architecture of the monastery is late Konbaung era (Yadanapon era) handiwork and consists of four apartments (shrine apartment, *sanu* apartment, main apartment and store). It was decorated with very fine wooden arts of the era, and it is recorded as the largest of the

late Konbaung era wooden monasteries. As time went on, only the main apartment remains due to natural disasters. The main apartment is 106' long, 100' wide and 56' high and is built of 143 timber posts with a diameter of one and half feet (Nat Maut Tun Shein 2010).

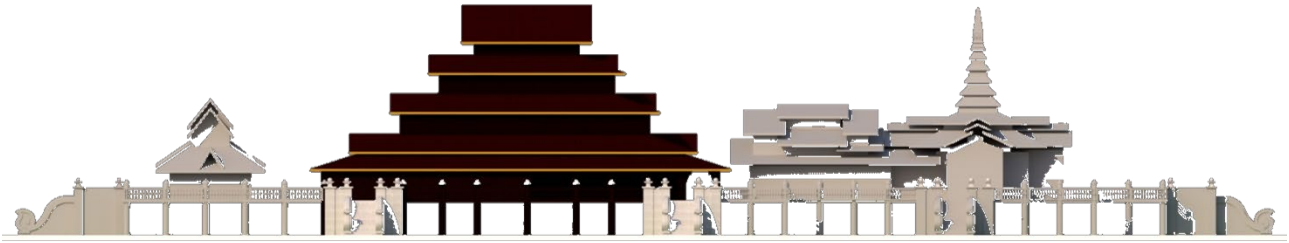

Fig. 4 An outline drawing for remained and disappeared parts of Maha-Minhtin monastery. Source: drawn by author, 2022[2].

Its roof has five stories and many of the late Konbaung-era architecture remains. But because of lack of maintenance and poor maintenance methods, high-value wooden artifacts are now being damaged in a short period, and the structural frames of the building are deteriorating. When studying the records of continual maintenance, it is observed that the building was repaired and maintained only three times, for the first time in 2001-2002, second in 2002-2004 and third in 2008-2009.

A look at the conservation processes performed during these three times shows in the following. In 2001 and 2002, the wooden arts of the doors were preserved, and minor maintenance was conducted, such as replacing the decayed wood from walls and floors (Department of Archaeology and Museum 2002). However, the monastery witnessed major conservation works from 2002 to 2004. At that time, the main problem of this wooden monastery was that it was subject to constant floods as (1) the land was lower than the surrounding area, (2) the lack of drainage lines to improve water flow, and (3) the use of water by the monks at the monastery (for bathing, washing clothes and cleaning utensils). Due to the constant flooding, subsidence of the ground occurred at the bottom of the wooden posts, and they became uneven. Consequently, the building was leaning. Additionally, the roof was damaged, and rainwater seeped into the timber roof structures and also caused ruin. Moreover, the wooden floors of the veranda were decayed and damaged by the weather. As such, the damage to the monastery was progressive on all sides.

As the first step, the water under the monastery was pumped out, which addressed the main problem. Then, it took time to dry the ground and return to its original state. The second step is that during the waiting period, the damaged roofs, walls, wooden floors and doors were systematically removed, and a temporary building was constructed to house them. The building was straightened out as a start when the soil from the floodplain returned to its original state for the third step. In that case, jacks were used to raise all wooden posts to the same level. Out of those posts, the non-reusable posts were replaced with new wooden ones. After that, the decomposed wooden posts in the ground were cut and replaced with reinforced cement concrete (RCC) round columns and attached to the remaining original logs. About one foot of hardcore was laid at the bottom of the RCC columns. The original type of foundation of the monastery, progressive steps for lifting wooden posts with jacks and building RCC columns are shown in photo records below.

[2] Discussion with U Win Maung (Tanpawaddy), a well-known traditional architect and archaeologist.

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Fig. 5 Lift wooden post with jack, connection between wooden post and RCC column and types of post foundation. Source: The first two photographs are taken by Department of Archaeology and Museum, 2002 and the last one is drawn by author, 2022.

After the building was erected, the main and secondary beams, timber floors and roof materials that were no longer suitable for use were replaced with new ones and new components were reassembled. By the time the building was repaired, drainage was dug to prevent further flooding (Department of Archaeology and Museum 2004).

After such major repairs, the following maintenance tasks were carried out for the third time in 2008-2009. First, the six destroyed Brahminy duck figures in the main apartment were replaced with new ones. Secondly, the roof sheets were painted to match the building and finally mineral oil was applied on the wooden walls (Department of Archaeology and Museum 2009). Conservation work that was done in 2008-2009 is the last one and no further maintenance action has been done until this day. The current situation of the Maha-Minhtin monastery, which was deteriorating on account of such a long time of abandonment, will be continually studied.

Assessment of the Threats of Maha-Minhtin Monastery

As regards the analysis of the current situation at Maha-Minhtin monastery not only the threats encountered but also the causes of these must be identified. In such a study, it will be divided into four assessments as follows:

1. Historical Assessment
2. Environmental and Site Assessment
3. Physical Assessment
4. Architectural Assessment

Historical Assessment

The original donor to the Maha-Minhtin monastery was U Bo (Min-Maha-Min-Hla-Thiri-Thinkha) who was the mayor of the two cities. The monastery was first built in the royal city of Innwa and moved to Amarapura in 1852. During the reign of King Mindon, the eldest son of the original donor, Sin-Wun-Maha-Min-Hla-Minhtin, moved it to Mandalay Nay Pyi Taw and donated it to Sayadaw U Tissa, the first abbot of the relocated temple. The Maha-Minhtin monastery is the only one to be relocated in three royal cities and is a wooden structure that is older than Mandalay. Moreover, this monastery is the largest wooden monastery in Mandalay during the Konbaung period (Nat Maut Tun Shein 2010). It is not only a historical building as described, but also a place for the new generation to learn about the social life of the late Konbaung monks and the relationship between the monastery and the people.

Environmental and Site Assessment

Maha-Minhtin monastery is located in the Maha-Minhtin monastic compound. It is also called the central monastery because it is in the middle of the compound, surrounded by 15 other monasteries. As mentioned earlier, the Maha-Minhtin monastery is slightly lower than the surrounding land, so when it rains, the water accumulates here. In addition, drainage ditches are located outside of the monastic compound. The canal dug near the Maha-Minhtin monastery in 2002-2004 was a pool made for aesthetic purposes only, which did not connect to any drainage. Therefore, during the rainy season, the pool overflows and floods under of the monastery. In such cases, it can take up to three months for the water under the monastery to dry up and the ground to return to normal. The rainy season in Mandalay runs from May to October. The heaviest rains are in August with an average of 28.8 days and typically up to 6.69" for that month (Weather Atlas 2021). During such rainy months, the base of the monastery and its surroundings are covered with rainwater all the time. The following shows records of Maha-Minhtin monastery being flooded in October 2021 due to heavy rains.

Fig. 6 Flooding around and under Maha-Minhtin monastery. Source: Photo by author, 2021.

Physical Assessment

The most important issues from natural threats include flooding, weather, and animals and plants; from man-made threats, the issues are fire risk and lack of routine maintenance.

Natural Threats

The damage to the building caused by the natural threats is studied and analyzed in the following sections.

Flooding

This is the most threatening issue for the building. On rainy days, water seeps under the monastery to a depth of 1.5 feet. The floodwater not only submerged the concrete shoes at the bottom of the wooden posts but also flooded the upper posts of the concrete shoes up to 6 inches. There are concrete shoes and RCC short columns at the bottom of the wooden posts that support the building, but no concrete shoes and RCC short columns under the posts that support the veranda around the building exist. Because of that, after the rain, the soil is moist and not as hard as usual and the wooden posts in the veranda on the north side of the building often collapse. On the night of 30 October 2021, heavy showers of rain caused the posts on the walkway to collapse. As a result, the columns became uneven and the main beam carrying the loading of the floor collapsed, and the floor was damaged. In addition, the area under the monastery is not exposed to direct sunlight and has poor ventilation, so it takes a long time for the soil to return to its original state after flooding.

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Due to floodwater caused by heavy rains on the night of 30 October 2021, the ground beneath the monastery did not dry up until the end of January 2022. It was such soil moisture that fungi can grow on concrete shoes and wooden posts, and ants and termites are infesting the wooden posts. The above-mentioned incidents are aftermaths of the flooding of wooden posts because of water accumulation under the monastery due to heavy rains. The situation is illustrated with the images below.

Fig. 7 Fungi on concrete shoe and wooden post, and the condition of main beam under the veranda floor. Source: Photo by author, 2022.

Animals and Plants

The second most dangerous issue of natural threats is from animals and plants. During the rainy season, when the foundation is flooded and the moisture of the wooden posts and the ground is high, the termites and ants consume the wood and make bores. Then, they make anthills and nest in the wood bores. There are nests of the termites not only in the wood bores but also in the highly humid wooden veranda floors. There is not any harm caused by these insects in the interior space where the moisture is low. The parts with the maximum damage from these insects are the lower part of the wooden posts and the veranda floors with constant exposure to water.

In addition to the insects, thousands of bats are living inside the roof of the building. The effects of their existence are the filth inside the building and the malodorous aroma because of their faeces. The worst downside is the presence of the bat's pile of faeces on the floor which causes the yellow stain on the floor. The threats of the animals mentioned above can be seen in the following photos.

Fig. 8 Damage of wooden post, veranda floor and interior floor caused by animals. Source: Photo by author, 2022.

Concerning plants, the bushes near the building are one of the main reasons for damage as they seem to be blocking the flow of the wind under the building and lead to a longer time for moisture to linger under the building. Moreover, the bushes also reduce the building's aesthetic value.

Weather

Strong winds can cause damage to the roof. When studying the roof of the building, it is seen that the south side of the roof in the windward direction is more damaged. Currently, the roof is covered with corrugated galvanized iron (CGI) sheets, and the original timber roof structures are found below it. The depredation allowed rainwater to seep into the building and damage the floors. Furthermore, there is leakage of rainwater through the connection between the roof and the wooden posts where rainwater is flowing along the posts. Due to the rain leakage, although the wooden floor and posts inside the building were damaged, about 70% have not yet been destroyed. However, if the roof problem is not solved in time, there is a risk of damage in the short term.

Fig. 9 Damage roof, and the flowing markings of wooden posts caused by weather. Source for the first photo: https://www.facebook.com/100002313436951/posts/3291084617645287/?d=n, Zay Myo Lin, 4 September 2020, sharing about the main problem of Myanmar wooden monasteries, and second photo by author, 2022.

Outside the building, the circuit is not supported with a cover and roof. 90% of the veranda floor was damaged due to weather and water use in the monastery. In addition, the wooden posts supporting the veranda are very weak because they have sunk due to the constantly wet soil. Moreover, when all the posts that mainly support the monastery are examined, it is found that the outermost posts are more damaged on account of weather. The figure below states the condition of the veranda floor as seen today.

Fig. 10 Condition of veranda floor. Source: Photo by author, 2022.

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Man-made Threats

There are many issues of man-made threats that can destroy the building, most important of them are fire risk management and lack of routine maintenance.

Fire

Since Mandalay is in a hot and dry region, fires are a pressing issue for wooden buildings. Historically, there have been no reported cases of electrical fires but there are almost many electronic devices in use, even by monks today. MORAC legislated and prohibited all residents of the wooden monastery from cooking and using other electric devices in the monastery which reduces the risk of fire. However, in Maha-Minhtin monastery, the use of low-quality wires in the monastery and an unorganized electrical wiring system poses a danger of fire through an electric shock. If a fire breaks out, there are two fire extinguishers for emergency use, but they are not adequate compared to the mass of the building. There is no other systematic protection to extinguish fires. If a fire occurs, it will burn the entire building quickly in a short time. Accordingly, fire threat is considered one of the most dangerous man-made threats to the monastery.

Lack of Routine Maintenance

As reported earlier, this monastery was the largest in Mandalay during the Konbaung era and was made up of four apartments. Due to deterioration, only one of the apartments remain. The remaining apartment was also maintained in 2008-2009, but there is no maintenance at all at present. The photographs below show a slightly deteriorating situation in a short period due to such routine maintenance failures.

Fig. 11 Condition of main beam under the north veranda in January 2020, in October 2021 and in September 2022. Source: Photos by author.

Architectural Assessment

Maha-Minhtin monastery is a monastery that still has some original architectural significance. The architectural assessment of the monastery is divided into three parts: (1) staircases (Thayet-kinn stair in Burmese) (2) exterior features and (3) interior features. When studying and analyzing these three parts, the authors will discuss the main causes of threats.

Staircases

There were originally four staircases leading to the remaining main apartment. However, the staircase situated in the southeast has been wholly destroyed due to flooding, rain, and lack of routine maintenance. The southwest staircase is part of the original structure and now 80% of it is ruined. The staircase to the northeast of the building is not original handiwork but is remodeled. These staircases are not only an important significant architectural feature of late Konbaung monasteries, but also a component that reinforces the strength of the building. Despite being such an important component, currently not only its original architectural features but also its structural strengths are lost.

Fig. 12 Staircase at the south side of Maha-Minhtin monastery. Source: Photo by author, 2021.

Exterior Architectural Features

When examining the exterior architectural conditions of the Maha-Minhtin monastery, the lack of handrails of the veranda stand out as they are lost. At the time late Konbaung wooden monasteries were constructed, the handrail designs and adornments were always decorated depending on the status of the donor, as a customary rule. The design of the handrails of the monastery donated by the King and the chief queen and adornment designs included in that donated by the royal staff are not allowed to be the same. Due to these rules, the status of the donor can be estimated by looking at the handrail designs of the late Konbaung period wooden monasteries. In this way, the complete disappearance of the original veranda handrails artifacts has reduced the architectural value of the monastery. In addition, some parts of the wooden floral barge-boards between the two posts supporting the roof edge of the main building were broken or damaged, and some have completely disappeared. In addition, about 90% of the wooden sculptures which are decorated at the entrances that can be said to be a significance of the late Konbaung monasteries has already been lost. Therefore, it can be considered that the original characters outside of the building face worrying situations. The above damage and problems are due to the weather and lack of routine maintenance. The pictures below state the current situation of exterior architectural features of Maha-Minhtin monastery.

Fig. 13 Current situation of exterior architectural features. Source: Photos by author, 2020.

Interior Architectural Features

The interior of the building is less damaged than the exterior. However, it stinks inside because of the bat droppings and dove dung. Due to the lack of daily cleaning, garbage and animal feces

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accumulate on the floor which causes yellow stains and air pollution. Although openings are left open for better ventilation and light, the walls of the building are not strong enough to be opened and always closed. Moreover, interior floors are slightly damaged by rain infiltration. Other artworks also are in need to be cleaned and to be maintained but these are minor tasks and the interior is not as bad as the exterior.

Discussion about Occurring Threats

The appropriate solutions of to the threats caused by natural and man-made factors are discussed, along with the challenges of maintenance and suggestions for future work.

Natural Threats

The damages caused by natural threats and the factors to be addressed as follows:

1. Drainage
2. Wooden posts, beams and floors
3. Veranda handrails, staircases, roof, and wood carving

Drainage

The threats existing for a long time in Maha-Minhtin monastery is flooding. It needs to be solved as a priority. The main source of flooding comes from the poor drainage system and happens due to the lower ground surface than the surrounding environment. Therefore, the first step is to create a drainage line around the monastery and connect it to the pool outside the campus of Maha-Minhtin monastery. The existing drainage line is about 200ft from the Maha-Minhtin monastery that is about 1.5 feet wide and 2 feet deep. It is clogged with garbage in the rainy season, resulting in poor water flow and the rise of water levels. As such, this drainage line should also be systematically upgraded. After that accomplishment, it should be connected to the proposed drainage through underground pipes to prevent visual and waste pollution. The connection plan of the drainage line outside the campus, the proposed drainage around the building and existing lake is presented with the following drawing.

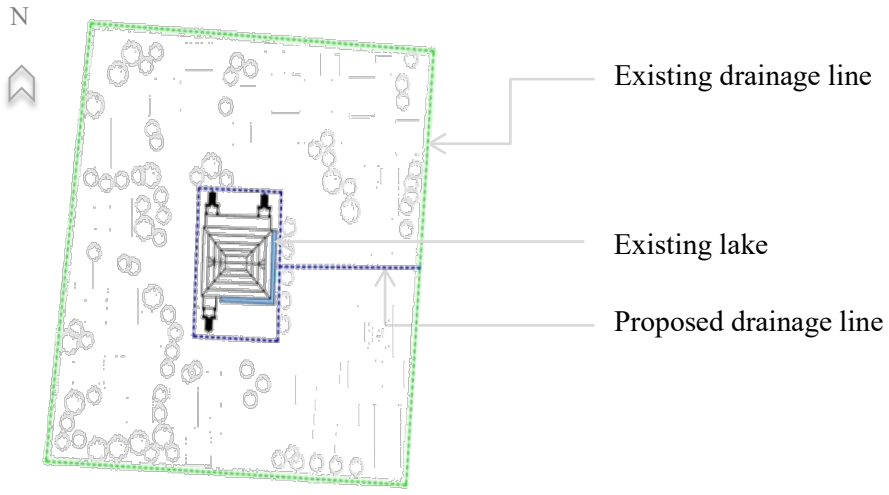

Fig. 14 Plan of existing and proposed drainage line. Source: Drawn by author, 2022.

When it rains, a perforated pattern cover design for the proposed drainage line will be used to allow rainwater from the surrounding area to enter it. It connects to the drain line outside the campus with a 0.25”/ft slope. As the slope of proposed drainage is 0.25”, the drain will be about four feet underground to meet the existing line. Therefore, the existing drainage must be upgraded to be

compatible with the proposed drainage which can then reduce the risk of flooding under the building.

Wooden Posts, Beams and Floors

As a second step, the strength of the wooden posts supporting the veranda must be inspected and replaced with new ones. Moreover, the posts should be reinforced with underground RCC columns to prevent subsidence as before. Then the ruined timber beams and flooring in the veranda must be totally replaced. The following drawing and table show the current damage level of wooden posts.

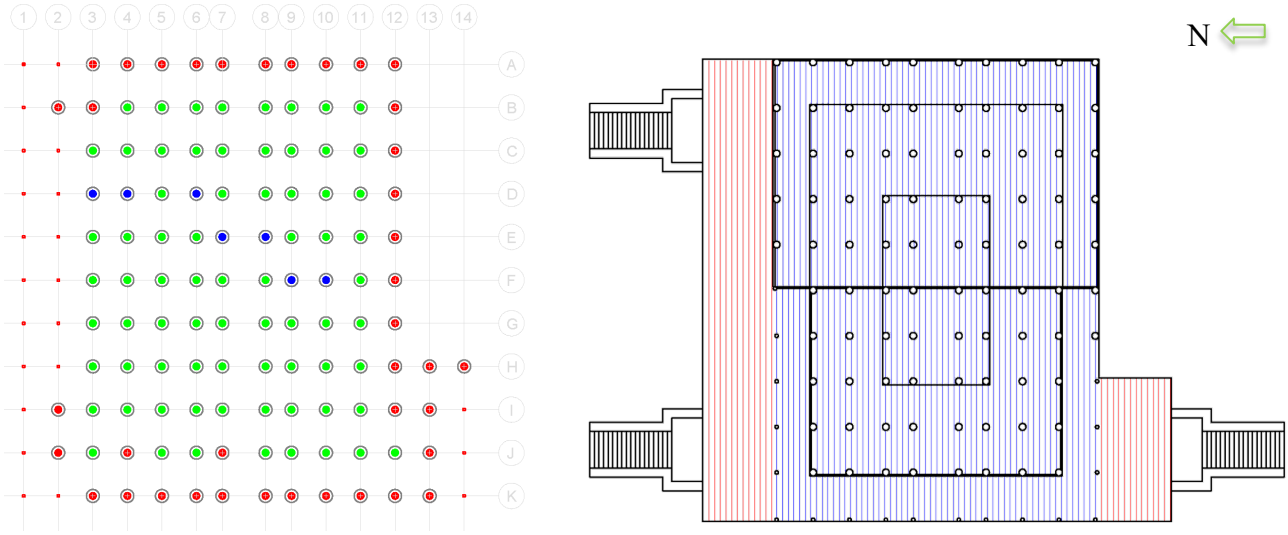

Fig. 15 Wooden posts and floor plan. Source: Drawn by author, 2022.

Total Replacement Partial Replacement Fair

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Name	Current Condition	Remark	Photo
A-3 to 12 B-2, 3 and 12 C-12 D-12 E-12 F-12 G-12 H-12, 13 and 14 I-2, 12 and 13 J-2, 4, 7 and 13 K-3 to 13	Crack line from top to bottom under the floor of the building	Replacement required	 Current condition of D-12 (The rest posts mentioned in this level are nearly the same.)
A-1 and 2	Crack line Low quality wood under north veranda With concrete shoes	Replacement required (cannot be used again)	
B-1 C-1 and 2 D-1 and 2 E-1 and 2 F-1 and 2 G-1 and 2 H-1 and 2 I-1 and 14 J-1 and 14 K-1, 2 and 14	Crack line Low quality wood under veranda Without concrete shoes	Replacement required Need to build concrete shoes	
Blue posts	With fungi and wood bores at the lower part of the posts	Partial replacement Need to remove the ants	 (Current condition of F-10.)
Green posts	Fair condition With fungi and ants	Need to preserve Need to remove the ants and fungi	
Red floor	Not easy to walk on Low quality wood With termites	Replacement	
Blue floor	Yellow stain caused by bats' feces	Partial replacement	

Table 2 Current condition of wooden posts.

Veranda Handrails, Staircases, Roof, and Wood Carving

Along with repairing the floor in the veranda, the handrails should be restored to their original handiwork. The handrails that are now visible seem to be plain and graceless and should be reconstructed in accordance with the characteristics of the monastery donated by the King's servants at the time. The approaching staircases also need repair along with the veranda works. The staircase to the south of the building is original but quite damaged. It is important for it to be reconstructed according to the original design of the staircase. The two staircases on the north side of the building should also be repaired in accordance with the original design. In addition, damaged roofs that weaken the physical strength of the building must be replaced. The roof structures under the roofing sheets must also be inspected in detail. The above-mentioned conservation work should be carried out in the dry season. After that, wood floral motifs and wood sculptures that enhance the value of the building need to be maintained after the necessary repairs for physical strength have been made. The wood floral motifs and sculptures are often left untreated for years and has accumulated dirt over time. These impurities cause harm to the original appearance of the wood carvings. When cleaning these contaminants, only non-destructive methods must be used. Wood carvings that were destroyed and lost must be replaced and restored like their original appearance.

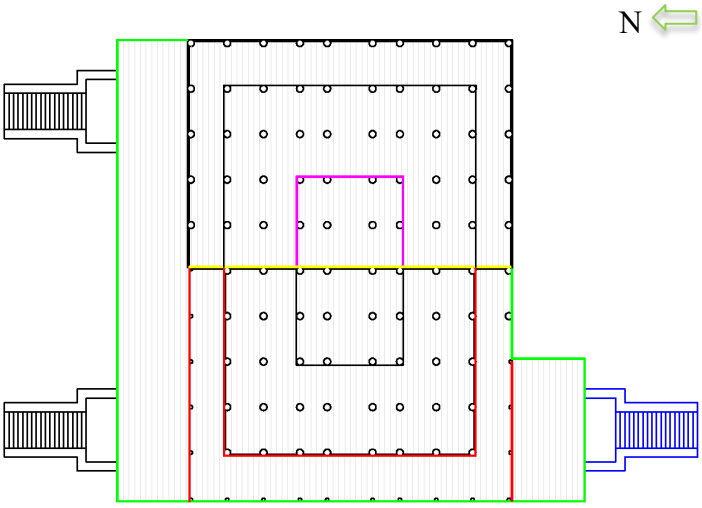

Fig. 16 Location of veranda handrails, wood carvings and staircase. Source: Drawn by author, 2022.

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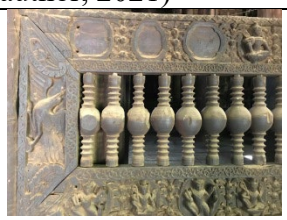
Name	Current Condition	Remark	Photo
Veranda Handrail (Green Line)	Totally lacking in the original character	Replacement required	 Handrail at the west side (Source: taken by author, 2022)
Doors and Windows (Red Line)	Some wood sculptures and carvings at doors and windows lost	Replacement of the lost parts required, according to original features Preserve the remaining parts	 Window at the south side (Source: taken by author, 2021)
Stage (Pink line)	Some wood sculptures and carvings at the stage handrails lost	Replacement of the lost parts required, according to original features Preserve the remaining parts	 Handrail at the north of stage (Source: taken by author, 2022)
Staircase (Blue line)	Poor condition	Reconstruction according to original features	

Table 3 Current condition of handrails, wood carvings and staircase.

Man-made threats

Fire

This issue is not only important for the Maha-Minhtin monastery under discussion but also for all wooden monasteries built in hot and dry areas. The wooden monasteries in Mandalay have been provided with fire extinguishers by MORAC for each monastery to prevent fire. Fire protection and fire alarm systems suitable for heritage wooden buildings need to be systematically researched and provided in addition to the fire extinguishers. Since this issue concerns all the wooden monasteries built in the tropics, more detailed research is needed to find solutions.

Routine cleaning and maintenance

Regular inspections and maintenance are needed to sustain the building at great length, and cleaning also plays an important role. The priority issues in regular cleaning are 1) cleaning the shrubs nearby the building and 2) removal of insects.

Although cleaning the shrubs is easy, removing insects requires more care. Systematic chemical treatments must provide under the guidance of insect professionals. Moreover, regular checks must perform to prevent further insect invasion. Regular cleaning is also needed to clean bats' faeces, dust, and garbage. These actions can reduce the threats caused by animals and plants. In addition to regular cleaning, the damage to the building must be inspected and recorded. Regular maintenance which is based on examinations can help to extend the building's life span. A lack of routine maintenance has already resulted in many losses, but at present, a regular maintenance system has not been performed yet. That is why heritage buildings are experiencing more damage in a short period. Heritage buildings need to be observed and carefully preserved against more losses.

Challenges

The challenges that will be encountered to properly perform the maintenance works must be considered and solved at the same time. The main challenges to be faced are: (1) availability of funds, (2) cooperation of experts in related fields, (3) human resources to conduct assessments under the guidance of experts, (4) skilled workers, (5) quality teak, and (6) sufficient time.

Suggestions for Challenges

As Myanmar is a developing country, it costs a lot of money on many basic needs in many sectors. Therefore, large amounts of money cannot be provided for the maintenance of heritage buildings. More than that, in the public sector, most of the people are willing to replace modern buildings rather than to maintain heritage buildings because they lack knowledge concerning heritage. Therefore, efforts should be made to raise public awareness of heritage. People, related government organizations and non-government organizations should work together to obtain the necessary funds. Moreover, the late Konbaung period wooden monasteries should be integrated as smart cultural heritage places to attract the local and foreign visitors for tourism development. It is also a plan to get income budget for these. Only with sufficient funds can systematic maintenance be carried out. For an example, the conservation works of Shwe Nan Daw Kyaung gets sufficient time and enough funds from WMF and local government. Moreover, local and international experts from each sector are collaborating in maintenance works. But the other heritage wooden monasteries are not easy to get the same opportunities as Shwe Nan Daw Kyaung. Therefore, to get sufficient funding is an important challenge for wooden heritage monasteries. The second challenge is the collaboration of experts from various relevant fields. This is a point that is experienced only in the heritage field but also in any other sectors. Cooperation between organizations and even between individuals is very weak. Therefore, it results in wasted time and results in having to do the same thing repeatedly and taking a long time to get a complete solution. Thus, the cooperation of relevant experts from various local and foreign organizations and the point to negotiate such cooperation is an important key to success for completion of a project. The third challenge can be solved by training and getting aspiring students from various universities involved that are related to this work field in conducting assessments under the guidance of individual experts. This solution provides students with not only theoretical experience but practical one. It also helps to become a new generation of professionals. The case of rare skilled workers in the maintenance of wooden buildings is a major challenge. While modern materials are plentiful, wood is being used less. As a result, some of the skilled wood workers are finding fewer jobs and shifting to other industries. Eventually, in addition to shortage of skilled wood workers and the number of generations who can pass on skills gradually declines. Because of it, low quality wood carvings and sculptures adorned heritage wooden monasteries. Moreover, meanings and the value of artworks can be devalued and decline. MORAC, who is responsible for maintenance of wooden heritage buildings, will have to hire skilled wood workers as permanent staff, provide courses on wood, and have to develop long-term plans for developing new generations of skilled workers. The fifth challenge is the difficulty in

getting quality teak, so other hardwoods are being used instead. The downside is that it does not last as long as teak, so it needs to be repaired more frequently. Therefore, teak should be planted separately for wooden heritage buildings like it is done in Japan in the case of the Tofukuji Temple in Kyoto. The sixth challenge is the responsibility of the relevant policy makers: policy makers should allow a reasonable amount of time recommended by the relevant experts to maintain a heritage building. Otherwise, if that policy makers set an unreasonable time, it may lead to incomplete business. Therefore, it is an important fact to have enough time to maintain a wooden heritage building. The above challenges and proper solutions apply not only to Maha-Minhtin monastery but also to heritage wooden monasteries in Mandalay. The following show the current working process undergoing maintenance of heritage wooden buildings and proposed working process required to suggest.

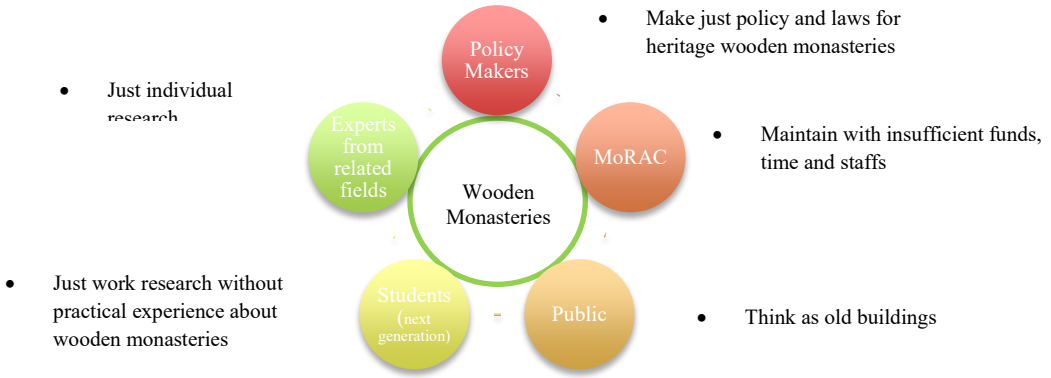


Fig. 17 Current working process for heritage wooden monasteries. Source: drawn by author, 2022.

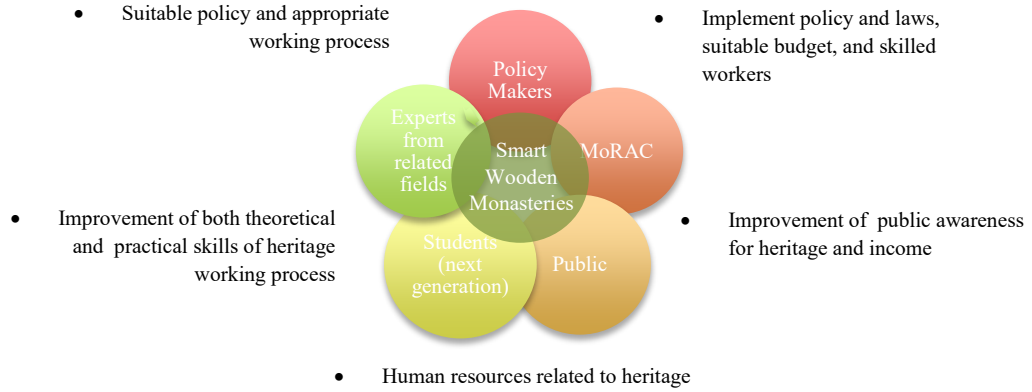


Fig. 18 Proposed working process for heritage wooden monasteries.

As it is stated in the proposed working process but because of cooperation, smart heritage wooden monasteries will become in real.

Conclusion

It is an important task to manage late Konbaung wooden monasteries in Mandalay, a tentative heritage site. As regards this paper through only the Maha-Minhtin monastery, which has the highest architectural and historical value and is most at risk of destruction was observed; the threats experienced by the late Konbaung wooden monasteries in Mandalay are largely the same. Moreover, the challenges that were identified are the same to be faced for all those monasteries. The solutions and proposed working process suggested above are considered in gross for all of them. When it comes to managing the threats of wooden monasteries to be performed as

recommended it results in more systematic and positive results. Therefore, it is hoped that this research will be helpful to organizations working on the maintenance of late Konbaung wooden monasteries.

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