Challenges in Material Management for Heritage Building Conservation in Malacca's UNESCO World Heritage Site

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ABSTRACT

Conservation projects differ significantly from conventional construction projects. Conservation work, especially regarding materials, requires specialized knowledge and experience. The materials used in conservation are distinct from those in typical construction because conservation efforts prioritize using appropriate expertise and authentic materials. In heritage building conservation projects, the choice of materials is crucial. As projects increase in scale, managing the resources for conservation materials becomes more complex, demanding advanced technologies to ensure timely and effective delivery. This research aims to explore the challenges in material management for conservation of heritage buildings in Malacca. The objectives are to identify current practices in managing conservation materials for the conservation of heritage buildings in the Malacca UNESCO World Heritage Site and to explore the challenges faced during this process. A qualitative methodology is employed, involving systematic interviews with stakeholders involved in a heritage building conservation project in Malacca. Six participants were interviewed. The findings underscore the challenges that always been faced in conservation projects and it is hoped that this research will benefit stakeholders to prepare in finding solution to overcome the challenges and contribute to more effective conservation project.

Keywords: material, conservation, material management, challenges, heritage buildings

INTRODUCTION

Materials management practices involve the planning, procurement, handling, stock and waste control, and logistics surrounding materials on construction projects (Albert et al., 2018). Managing conservation material is important as managing construction material to maintain the historical value of historical building. Material management plays a crucial role in the conservation of heritage buildings works. These structures often have historical, cultural, and architectural significance, making their preservation a complex task that requires careful planning and execution. Materials management is the system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost and most importantly are available at the point of use when required. (Sanni and Eyiah, 2022). Effective material management ensures that the original character and integrity of the heritage building are maintained while accommodating necessary repairs and improvements. Materials management for heritage building conservation involves careful selection, use, and care to ensure the original character and integrity of the structure is preserved, as well as to extend the life of the building. This process

is very important because the materials used in heritage buildings usually have unique properties and cultural values that require specific knowledge to ensure their conservation is carried out effectively.

Material management is at the heart of the effectiveness of a conservation of heritage building project, as it directly affects cost, schedule, and final quality. According to Wayrah et al., (2021) materials management is an important aspect of construction project management. Material management practices require adequate planning and controlling the quality and quantity of the material, punctual equipment placement, good price and the right quantity as required (Madhavi, Methew, & Sasidharan, 2019). With good management practices, any delays can be avoided, unnecessary expenses can be reduced, and efforts to build sustainably can be realized through the reduction of waste and the optimization of the use of available materials. Historic structures are a unique resource and cannot be replaced. The purpose of material management is to ensure that the supply of building materials is always sufficient and available on time, so that every need can be met smoothly without any interruption in the construction process. According to Ashika (2019) A proper implemented material management program can achieve the timely flow of materials and equipment to the jobsite, and thus facilitate improved work face planning, increased labour productivity, scheduling and minimize the cost.

LITERATURE REVIEW

MALACCA UNESCO WORLD HERITAGE SITE

The Historic City of Malacca stands out with its unique cityscape, formed by streets and buildings that create a special atmosphere. Compared to other cities in Malaysia, Melaka's urban landscape has its own uniqueness with a combination of closed areas featuring houses, shops, and offices that complement each other. Along the narrow streets of Malacca, rows of shophouses stand majestically on both sides of the road, most of them one or two stories high. From simple two-story buildings with minimalistic facades, to more complex three-story buildings with different architectural styles and influences. The street scene in this historic area is enriched with a strong element of surprise, thanks to the winding and winding narrow streets. In July 2008, Melaka has been described as World Heritage Sites by UNESCO. Malacca bears witness to the rich diversity of Asian cultures and traditions, where various heritages and influences from across the region can be found and felt. Malacca, which has its roots in the Malacca Sultanate in the 15th century, has gone through a tortuous history, including colonization by the Portuguese from 1511 to 1641, and the Dutch from 1641 to 1824, before coming under British rule from 1824 to 1957. Today, Malacca is recognized as a UNESCO World Heritage Site, which is divided into two important zones: the core zone and the buffer zone.

The Malacca Historic City Core Zone includes two main areas. The first is civic zone, Bukit St. Paul, which houses various government buildings, museums, churches, town squares, and the remains of the original fortified city from the Portuguese and Dutch era in the 16th century. Second is The Historic Residential and Commercial Zone has more than 600 shop houses, commercial and residential buildings, re ligious buildings and tombs on four main streets: Jalan Tun Tan Cheng Lock (Heeran Street), Jalan Hang Jebat (Jonker Street), Jalan Tokong, Tukang Emas, Tukang Besi and Jalan Kampung Pantai; as well as on four perpendicular streets of Lorong Hang Jebat, Jalan Hang Kasturi, Jalan Hang Lekiu and Jalan Hang Lekir (Koh, 2017). Buffer Zone is being protected and covered by 134.03 hectares of Buffer Zone, bounded by Jalan Merdeka, Jalan Kota Laksamana, Jalan Ong Kim Wee, Jalan Tan Chay Yan, Jalan Munshi Abdullah, back lots of Kampung Banda Kaba, Jalan Chan Kwn Cheng and Jalan Merdeka (Koh, 2017).

Heritage buildings in Malacca that have been restored reflect the city's rich history and architecture. Some prominent examples of heritage building that have been conserved include Stadhuys Building, Christ Church, A Famosa, Poh San Teng Temple, Kling Village Mosque and St Paul Church. Most of the building was built around 1500- 1700 in the era of Dutch colonial in Malacca. Beside administration building, religious building also part of iconic heritage building in Malacca.

Figure 1: Heritage buildings in Malacca. a) Stadhuys, b) Christ Church, c) A Famosa Fort, d) Poh San Teng Temple

Source: Wikipedia (2024)

CONSERVATION PROCESS

Conservation is all the process of looking after a place to retain its cultural significance which are aesthetic, historic, scientific, social or spiritual value for past, present or future generations. (Burra Charter, 2013). Conservation can be defined in a wide and varied meaning which involves two different definitions of its own word. The definitions are restoring and preserving. Based on heritage building context and activities, the term of conservation is more focused on the practical meaning, which is the method of conserving the historical buildings and monuments which contain many stories about the past starting Malaysia had been colonized by other countries until the moment Malaysia got its own independence on 31 August 1957. Building conservation works in Malaysia gained momentum since the joint inscription in 2008 called the cities of Malacca and Georgetown as World Heritage Cities (Mui et al., 2016).

Hegazy (2015) stated that conservation is one multi-disciplinary process which involves the understanding, considering, interpreting and management of architectural heritage to distribute it safely for future generations. The theory also can be described as the process of retention or reintroduction of use, maintenance, preservation, reconstruction, restoration, adaptation, interpretation and it can be a combination of more of works. Management of conservation material can be approach in serving human needs by using or reusing same resources with most productively and sustainably throughout the histories, backgrounds, and life cycles (Edike, 2021).

It is to make sure the historical value can be maintained to do some conservation works on it. According to Jabatan Warisan Negara (2016), conservation can be defined as a process of maintaining and overseeing a historical building from being destroyed or recovered without systematic planning and management. ICOMOS has provided charters that contain standards and guideline for conservation such as Venice Charter, Burra Charter and New Zealand Charter which to clarify and reinforce the meaning of conservation, international bodies engaged in this area have developed and given a wider and more precise meaning of conservation in term of their understanding. There is conservation principle that must be follow which are authenticity of material, authenticity of design, authenticity of workmanship and authenticity of setting.

Authenticity in Material

Authenticity in conservation material is one of the principles that must be abide in conservation works. Conservation materials are considered as a significant value towards the building which has brought together the value of the historical building. Li (2017) stated that the materials in heritage building are evidence-proof of knowledge, ideas and building excellence. The authenticity must be investigated in all aspects in legality, sources, material contents, material types, criteria of materials such as its colour, texture, appearance,

collection and supplier including material properties that cause it to be used as materials for the heritage or historical buildings.

The use of traditional materials and techniques is often necessary to maintain the originality of the building. However, in certain circumstances, modern materials can be used if they provide better durability or conservation benefits, without compromising the original aesthetics and structure. When the original material is no longer available, the effort to source material that closely resembles the original material is very important. For example, the use of hydraulic lime mortar, which is more compatible with historic masonry than Portland cement, can prevent issues like moisture trapping that may cause further damage (Forsyth, 2007).

MATERIAL MANAGEMENT

Materials management includes a few process that involved management, monitoring and action. According to Wayrah et al., (2021) material management is a construction process that involves planning, executing, and controlling field and office activities. Materials management refers to the concerted effort to plan, obtain, handle, and use materials efficiently to ensure that each material is available on time and utilized to the best possible extent throughout the course of the project. It reflects a chain of actions that begins with procurement, where materials are ordered based on project-specific requirements, agreed quality, and prices determined through careful negotiation with suppliers. There is proper way to manage the material to make sure the project can run smoothly.

Assessment of Materials

The first step in materials management is to assess existing materials to understand their condition, properties, and historical value. This assessment helps identify the authenticity of materials as well as any repairs or replacements that needs to do. It also reveals problems such as damage, structural weakness, or environmental effects that can damage the material. As Ashurst and Ashurst (1988) point out, this assessment is important because it forms the basis for making decisions about whether to conserve, restore, or replace materials based on their condition and historical significance. The main goal is to preserve as much of the original material as possible, as it contributes to the originality and historical value of the structure.

Selection of Right Material

The selection of the right material for conservation is an important aspect in ensuring the success of the work. The main aims is to use materials that are compatible and match the original material in terms of appearance, composition, and performance. According to Maner & Patil (2024) to properly supply the materials, a good understanding of different type of materials is needed in order to select the materials according to their sizes, time of the usage on site and other factors.

Sourcing and Procurement

In terms of sourcing and procurement, materials should be obtained from ethical suppliers, especially if the materials are difficult to find or have high cultural value. Material management comprises a series of processes that need to be well integrated, organised and managed to ensure material is accessible when required (Wayrah et al.,2021). This process is accompanied by strict evaluation on material to ensure that the immaterial are authentic When the original material is no longer available, the effort to find material that closely resembles the original material is very important. This information not only supports current conservation efforts but also guides future interventions by providing a historical record of the materials and methods employed (Stanley-Price, 1995).

Labelling, Storage and Handling

Proper labelling and storage in appropriate conditions are also important steps to reduce the risk of cross-contamination or the use of inappropriate materials. For example, archival materials should be stored in acid-

free boxes, while textiles should be stored in a climate-controlled environment to ensure a long shelf life. The storage and handling of the material must be done carefully to avoid damage before the material is used. This includes controlling environmental factors such as temperature, humidity, and exposure to light, which can help maintain the quality of sensitive materials. According to Albert et al., (2018) poor handling of construction materials affects the overall performance of construction projects in terms of cost, time, quality and productivity.

Inventory Management

As for inventory management, a systematic approach is needed to track available materials. This includes noting the quantity, storage location, and expiration date of the material. This management helps in ensuring the efficient use of stock. Stock rotation procedures can be implemented to ensure that older materials are used first, thus reducing wastage. According to Hassan Murshid and Ismail (2022) inventory management determines the quantity of materials held in stock. This also allows material managers to handle the organization's operations more accurately and efficiently, through the separation of each segment in the overall operation. This process includes the evaluation of goods entering the store as well as the systematic distribution of stock. In addition, it is wise to keep an emergency stock of critical materials, in case of unexpected needs in conservation.

Condition Monitoring

Preventive conservation involves measures taken to slow the deterioration of materials through the management of environmental factors such as humidity, temperature, and exposure to pollutants. Material monitoring and control is referred to as techniques for construction management practices, where three main categories of object detection, object tracking, and action recognition (Kazemian et al., 2019). It is very importance to make sure the works is done with quality material to prevent the works from occurs in short time.

Application techniques

Application techniques in the conservation of historic buildings play an important role in maintaining the originality and appreciating the existing architectural heritage. The use of traditional construction methods during the conservation process not only helps to conserve the original features of the building, but also ensures that this heritage continues to be appreciated. Therefore, the involvement of a skilled and experienced labour is very essential to ensure that every works is carried out to the highest standard (Hussain and Vidya, 2023). At the same time, the compatibility of the new material with the existing structure needs to be carefully examined to avoid problems such as unbalanced movement, moisture retention, or unwanted chemical reactions.

Material management in this conservation project is actually quite complicated, but important. It involves various steps such as planning well, finding materials in the right way, storing them well, and making neat documentation. All of this is important to ensure the conservation process runs smoothly. Each step helps us reduce risk and maintain the quality of materials, hoping to extend their lifespan and make cultural heritage conservation efforts more effective.

CHALLENGES IN MANAGING CONSERVATION MATERIAL

Material management in conservation projects is full of challenges. Especially because we need to look after, save, and restore very valuable historical objects and materials. These challenges can greatly affect the quality and success of our conservation efforts. The following is an explanation of the main challenges and potential impacts that may arise.

Sourcing of Authentic Materials

Finding materials that match the original composition or construction of historical artifacts is often a difficult task. Many traditional materials are no longer produced, or their use may be prohibited for environmental reasons. For example, certain types of wood or pigments may have been protected or banned from use. When authentic materials cannot be obtained, using inappropriate substitutes can compromise the authenticity and stability of artifacts, further reducing their quality and historical integrity. The difficulty of finding the exact same type of materials used is one of factors influencing material of conservation works. According to Spigliantini et al. (2017), the historical building that want to conserved must be stay having historical value, that why contractor should find out the supplier or person that mostly in old generation to get supply. Supplier of conservation material also is causing the higher price of materials used, make the price of tender also high. Besides, numbers of contractor that get in into the tender also in a small division. The competitiveness and reasonableness of price will be doubt by the issue when there is high variability among the tender's amounts.

Skills and Expertise Gap

Historical building is important to be conserved because to maintain the quality and value of history. Tourists also can visit the historical building besides can get more information and stories behind the historical building. Every works has their own challenge same as this conservation works. First, lack of technical perspective which including lack numbers of specialist. The process of making the materials aside to maintain the value of historical needs a lot of expertise (Kayan, 2015). This making of materials requires a higher degree of expertise and should be diligent and careful to ensure they produce quality materials while maintaining historical value. It is because the building in conservation projects is often unique and having specialist skills on knowledge regarding the projects (Zolkafli et al., 2015).

Storage and Handling

Storage at the construction site is essential so that the materials already available when needed (Mat Jusoh and Kassim, 2017). Conservation materials, including chemicals, adhesives, and fragile artifacts, often require specific storage conditions such as controlled temperature, humidity, and light. Failure to manage these conditions may cause material deterioration before restoration is carried out. In addition, after conservation, inadequate storage conditions can affect the lifespan of the artefact, thus negating the conservation efforts that have been carried out. Material handling can be defined as the function associated with the preparation, placement and positioning of materials to facilitate movement or storage (Sianturi et al., 2022). According to Maner and Patil (2024) the inefficient handling of materials during construction site operations is an issue that significantly impacts the performance of construction projects.

Budget Constraints

High quality materials for conservation usually involve high costs. Coupled with special storage or handling requirements, the overall cost of the project will increase. In addition, the higher price of materials also one of factor influencing material conservation on historical building. It is because the difficulty to find the supplier of the materials. According to Huuhka and Vestergaard (2020) conservation also having related with circular economy (CE) which is concept of reuse of pre-used objects and materials conceived as something undesirable in growth and consumption oriental. Other than harder to find supplier is causing the higher price of materials used, but the price of tender also high. Besides, numbers of contractor that get in into the tender also in a small division. The competitiveness and reasonableness of price will be doubt by the issue when there is high variability among the tender's amounts.

Original Documentation and Tracking

Conservation requires detailed documentation of the materials used, their sources, and the methods applied. Careful records are essential for future maintenance and continued conservation of artifacts. Without good

documentation, future conservation efforts may be difficult, in addition to facing legal issues related to authenticity and loss of historical accuracy.

Effective material record management will facilitate the flow of materials on site, while avoiding problems such as out of stock and undelivered materials. It also provides guides to all the subsequent activities and this could have a great impact on the project plan (Maner and Patil, 2024).

Lack of interdisciplinary knowledge and combination between sciences, technologies and arts

Heritage conservation work agonize because of unavailable skill workmanship. The sciences and arts are important elements in applying in the conservation works because the historical buildings have their own value to be maintained. The production of materials should be the special craftsmen to produce the quality products by using sciences and arts studies. Hence, the conservation woks which complex in technical factors relating to perishability of material, strong structure and lastingness landscape value (Roy and Kalidindi, 2017).

Shortage of Material Supplies

A shortage in the supply of conservation materials occurs when the demand for materials used for preservation and restoration exceeds the amount available. This situation can be caused by several factors, such as increased demand, disruptions in the supply chain, shortages of raw materials, manufacturing problems, regulatory changes, economic conditions, or environmental impacts. These challenges can limit the production and availability of critical resources needed to ensure the smooth running of conservation efforts. Yung and Chan (2015) stated that the shortage included materials, labour, equipment and financial constraints as main contributory variables which causes construction delays.

Environmental and Safety Regulations

Heritage buildings are exposed to various risks that can threaten their material and structural integrity and authenticity, and therefore need to be well managed (Bahtiyar and Disli, 2022). The field of conservation is subject to various regulations governing health, safety, and the environment. Traditional materials that were once used may now be classified as hazardous or no longer meet regulatory standards. Therefore, safer alternative materials should be sought, even if their performance may not be the same as the original material. This can affect the authenticity and effectiveness of conservation work.

Conflict interests of stakeholder

To manage the conservation materials, it will become more difficult if having conflicts from stakeholders. Even if public participation is ensured, lack of effective mechanism, conflicting interests of stakeholders, power disparity, and lack of knowledge limits the benefits of such participation (Yung and Chan, 2015). Besides, according to Roy and Kalidindi (2017), one of challenges faced is conflict interests involved by stakeholder which also participation of the community in the heritage project during and post-restoration.

RESEARCH METHODOLOGY

QUALITATIVE METHOD

There are three (3) differences stated in research approaches. Creswell (2014) mentioned types of research approaches are qualitative, quantitative and mixed method. In this research, a qualitative method is use for this research as an approach to collect and accumulate significant data. In addition, qualitative method used in this research seeks to understand the stakeholders', contractor's and conservators' roles in managing conservation

material for historical buildings in Malacca UNESCO World Heritage Site. Qualitative method also can express in numbers and graphs to test or confirm theories and assumptions. This type of research will help in generalizable facts about the study (Streefkerk, 2019).

DATA COLLECTION

In each research, data can be collected and obtained in various techniques, different sources and different settings. Data sources can be primary or secondary and some of the researchers will used sources in collecting data. In completing this research, certain steps need to be taken into consideration and the steps are:

Primary Data

On primary data, research methodology involves a qualitative approach using interviews have been done. Six respondents who are directly involved in conservation projects have been selected. The list of respondents is obtained from the Majlis Bandaraya Melaka Bersejarah. In this study, structured interviews were conducted. A structured interview is a type of oral questionnaire, where a set list of questions is asked consistently, without much variation and without room for follow-up questions that require additional detail. These panel of respondents' opinion may be sought on specific issues, which for this research's issue in managing conservation material for conservation of historical building in Malacca UNESCO World Heritage Site. This approach allows for in-depth understanding and insights into the experiences, opinions, and perspectives of individuals actively participating in the projects. This approach can yield rich qualitative data that captures the complexity and nuances of conservation efforts in Melaka.

Secondary Data

The literature review in this research focuses on the collection of secondary data. The first step involves clearly identifying and understanding the topic of the study. The focus of the study includes the problem statement, goals, questions, objectives, and scope of the study. Secondary data used is information that has been collected for other purposes and obtained from various sources, including reference books, journals, articles, and online websites. Through this literature review, the study provides a comprehensive overview of the management of heritage building conservation materials at the Melaka UNESCO World Heritage Site.

DATA ANALYSIS

The data collected for this research will be analysed using content analysis techniques. The information obtained from the literature review and interviews will be studied to achieve the objectives of the study. Input from interviews will be carefully analysed. This technique aims to analyse the responses from the interviewees or respondents. In addition, any documents obtained from the relevant parties will be examined to obtain information on the management issues of the conservation of heritage buildings in Melaka.

ANALYSIS AND FINDINGS

The data analysis for this study will be used the content analysis technique. The information and data gained from literature review and interview will be studied thoroughly. The input obtained from the interviews will also be analysed and conducted. It is usually used to analyse responses from interviewees or respondents. Any documents obtained from the selected parties involved are evaluated to gain information about issues related with management of conservation materials. This analysis is divided into three main parts. The first part focuses on the demographics of the respondents. Next, the second part analyses data related to the first objective, which is to identify current practices in material management for the conservation of heritage buildings at the Melaka UNESCO World Heritage Site. Finally, the third part examines the data for the second objective, which focuses on the challenges in material management for the conservation of heritage buildings on the same site.

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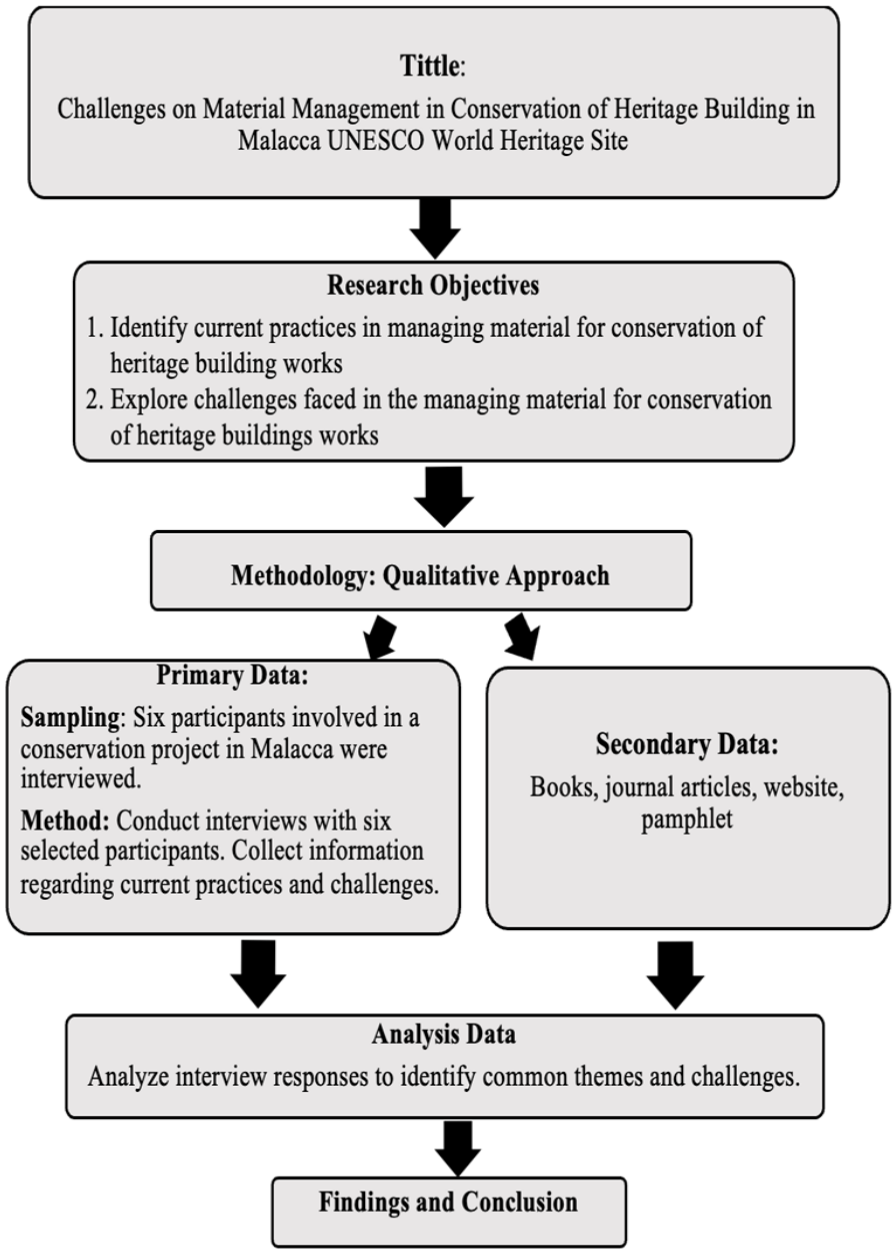

Figure 2: Flow Chart of Research Methodology

Demographic of Respondent

Table 1: Demographic of Respondent

IV	AGE	POSITION	EXPERIENCES	INVOLVEMENT IN CONSERVATION PROJECT
R1	40	Client -	- 20 years' experience in Construction industry - 8 years' experience in Conservation projects	5 Conservation Projects with various type of heritage building.
R2	41	Client	- 10 years' experience in Construction industry - 2 years' experience in Conservation projects	1 Conservation Projects and just started involve in conservation.

R3	54	Client	- 35 years' experience in Construction industry - 28 years' experience in Conservation projects	20 Conservation Projects with various type of heritage building.
R4	52	Conservator	- 30 years' experience in Construction industry - 22 years' experience in Conservation projects	10 Conservation Projects with various type of heritage building.
R5	55	Contractor	- 15 years' experience in Construction industry - 5 years' experience in Conservation projects	2 Conservation Projects- seldom get a conservation project.
R6	34	Contractor	- 10 years' experience in Construction industry - 1 years' experience in Conservation projects	1 Conservation Projects and just started involve in conservation.

Table 1 provides information about six respondents which involved in conservation projects, including their ages, roles, industry experiences, and the number of conservation projects they have participated before. The respondents' roles are categorized as clients, conservators, or contractors, with varying years of experience in both the construction industry and conservation projects.

The age range of the respondents are from 34 to 55 years, indicating a mix of mid-career and senior professionals. Those identified as clients typically have longer careers in construction, with experiences ranging from 10 to 35 years, but their involvement in conservation projects varies. For example, Respondent 3 (R3) is highly experienced in both fields, with 35 years in construction and 28 years in conservation, having worked on 20 projects. In contrast, Respondent (R2) has less experience in conservation, with only two years, and has participated in just one conservation project.

The Respondent (R4) and Respondent (R5 and R6) also exhibit diverse backgrounds. The (R4) conservator, aged 52, has significant experience with 30 years in the construction industry and 22 years in conservation, contributing to 10 conservation projects. The contractors show different levels of experience, with R5 having more time in construction (15 years) and conservation (5 years) compared to R6, who has 10 years in construction but only a year experience in conservation.

Overall, the data reveals varying degrees of expertise among the respondent, with some having extensive backgrounds in both construction and conservation, while others are relatively newer to conservation work. This variation likely influences their perspectives and approaches to conservation projects, depending on their depth of experience

Objective 1: To Identify Current Practices in Managing Conservation Materials for the Conservation of Heritage Buildings in The Malacca UNESCO World Heritage Site

Table 2: Current Practice on Material Management in Conservation of Heritage Building in Malacca UNESCO World Heritage Site

	Description	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**
1	Assessment of Materials	/	/	/	/	/	/
2	Selection of Right Material	/	/	/	/	/	/
3	Sourcing and Procurement	/	/	/	/	/	/
4	Labelling, Storage and Handling	/		/		/	/

5	Inventory Management		/			/	/
6	Condition Monitoring	/	/	/		/	/
7.	Application Techniques	/	/	/	/	/	/

The table 2 titled "Current Practices of Materials Management in Heritage Building Conservation Projects" provides an overview of various practices related to materials management in the context of heritage building conservation. These practices are divided into several areas of focus, where each row represents a specific practice. Columns labelled R1 to R6 refer to different respondents or case studies involved in conservation projects.

First practice was “Material Evaluation”, it shows that all respondents, from R1 to R6, are actively involved in this practice. This reflects a clear understanding of the importance of assessing existing materials before starting any conservation work. Ashurst and Ashurst (1988) already point out, that assessment is important because it forms the basis for making decisions. Then the second practice is “Proper Material Selection”. Similar to the previous practice, all respondents agreed on the importance of choosing the right material for conservation, so that the material is in line with the original material in terms of appearance and performance. Maner & Patil (2024) agreed and stress out that knowledge on conservation material is importance in selection of the right material for the conservation works.

Thirdly, “Sourcing and Procurement” became the focus, where all respondents indicated involvement in these practices. This shows that there is a shared awareness of the need to obtain the right materials to ensure the success of conservation efforts. Wayrah et al., 2021) also agreed and stated that the sourcing and procurement is very importance in the conservation works. Moving to the next practise ,is “Labelling, Storage, and Handling” are discussed. In this aspect, respondents R1, R3, and R6 showed involvement, while R2 and R4 did not register participation. This non-uniformity may indicate that there is a difference in approach or level of focus towards the proper management of materials throughout the conservation process.

Next, is “Inventory Management”, only respondents R2 and R6 are involved, indicating that this practice is not implemented uniformly among all respondents. This may indicate a gap in the system of tracking and organizing is necessary to materials. The practice of “Condition Monitoring” is observed. Respondents R1, R2, R3, and R5 were involved in monitoring the condition of the material, while R4 did not participate. This showed that monitoring is important to ensure that the materials used in conservation are always in good condition throughout the process. Kazemian et al, (2019) also mentioned the importance of monitoring the condition of material to provide good quality of conservation works. Finally, on the last line that refers to “Application Techniques”, all respondents showed high involvement. This reflects a consensus on the importance of using appropriate techniques by labour to ensure effective application of techniques in conservation works (Hussain and Vidya, 2023).

Overall, this table shows a comprehensive approach to current practice on material management in conservation projects. The data obtained shows a strong emphasis on aspects of evaluation and selection of materials, but also suggests opportunities for improvement in aspects of inventory management in the field of heritage building conservation.

Objective 2: To Analyse the Challenges in Managing Conservation Materials for The Conservation of Heritage Buildings in The Malacca UNESCO World Heritage Site

Table 3: Challenges on Material Management in Conservation of Heritage Building in Malacca UNESCO World Heritage Site

	Description	R1	R2	R3	R4	R5	R6
1	Lack of Authentic Material Resources	/	/	/	/	/	/
2	Shortage of skills and expertise	/	/	/	/	/	/

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3	Storage and handling issues	/	/		/	/	/
4	Budget constraints			/	/		/
5	Issue on original documentation and tracking	/	/	/			/
6	Shortage of material supplies	/	/	/	/	/	/
7	Lack of interdisciplinary cooperation and combination between sciences, technologies and arts	/	/	/	/	/	/
8	Environmental and safety regulations				/	/	/
9	Conflict interests of stakeholder				/	/	

Table 3 gives us a clear view of the various challenges in material management during the conservation of heritage buildings. Each row in this table represents a specific challenge, while the columns marked R1 to R6 refer to different respondents in this study. First, the issue of "Lack of Authentic Material Resources" really stole the spotlight, where all respondents from R1 to R6 agreed that this is a common problem in the field of conservation. They all admit that it is difficult to get genuine materials for conservation work. Spigliantini et al. (2017) also agreed it is difficult to find a right supplier for the authentic conservation material. Second, there is the "Shortage of Skills and Expertise," which was also acknowledged by all respondents. Supported by Hussain and Vidya (2023) that skilled labour is very important to produce quality works. This shows that respondent are concern about the shortage of trained professionals who have important knowledge and skills in conservation, which may affect the effectiveness of the project.

Next, there is the issue of "Storage and Handling Issues." Respondents R1, R2, and R4 expressed their experiences regarding this challenge, but R3 and R5 did not face any problems, so their approach may be different. The fourth issue, “Budget Constraints,” was only raised by R3 and R4. This suggests that financial problems may hinder conservation efforts, and perhaps other respondents do not face the same situation.

The fifth issue is “Issues on Original Documentation and Tracking.” R1, R2, and R3 all acknowledged that keeping accurate records of conservation materials is a common challenge, emphasizing the importance of good documentation management. The six issue is about “Shortage of Material Supplies," where all respondents agree this is an important problem. This shows how difficult it is to source the materials needed consistently in conservation projects. Yung and Chan (2015) stated that the shortage will affects the works such as delay and inefficient cost of conservation works. In the seven issue, all respondents also acknowledged the challenge of " Lack of interdisciplinary cooperation and Combinations Between Science, Technology and Art." This shows the need for better cooperation between various fields to facilitate conservation efforts.

The eight issue relates to “Environmental and Safety Regulations.” Only R4 and R5 perceived this as a challenge, indicating that not all respondents face problems in complying with safety and environmental standards. Finally, the issue of “Conflict Interests of Stakeholder” was raised by R4 and R5. This suggests that differences in priorities among stakeholders can complicate the decision-making process in conservation projects.

Overall, this table summarizes the main challenges and issues in materials management for the conservation of historic buildings. It shows agreement among respondents on issues such as the lack of genuine material sources and skill gaps in this field. Additionally, the table also highlights specific logistical issues and the importance of interdisciplinary collaboration, while showing that how different projects address these challenges may vary. As mentioned by Mat Jusoh and Kassim (2017) the impact of materials management needs to be explored more deeply to gain better insight and understanding, in order to improve project performance through effective materials management practices.

CONCLUSION

This research has examined the challenges in material management practices for the conservation of heritage buildings in Malacca. This paper discusses the various challenges faced. Among the main issues faced by

respondents are the lack of authentic materials, lack of skills and expertise, storage and handling problems, and budget constraints which are the main concerns. Based on the results of this study, it can be concluded that the challenges in material management practices differ from one project to another. There should be proper planning of material management for conservation of heritage building right from the inception of project execution until the conservation work completed.

Effective materials management in conservation works requires a careful approach to address multiple challenges. This includes systematic planning, compliance with established regulations, complete documentation, and ongoing training for all parties involved. Addressing these issues is very important to ensure the authenticity, stability, and historical integrity of cultural heritage building continue to be preserved and valued. Overall, the management of materials in the conservation of heritage buildings is a complex and important process in an effort to maintain the authenticity and heritage value of historical structures. The approach taken needs to be. Thoughtful, considering not only the physical aspects of the material, but also the cultural and historical value it possesses. Through careful planning, accurate sourcing, careful handling, and careful documentation, material management ensures the survival and appreciation of heritage buildings, so that they remain sustainable and appreciated by future generations.

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