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"Sustaining the Resilient, Beautiful and Safe Cities for a Better Quality of Life"

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RIGHT-TO-KNOW ON RISKS FROM EXPOSURE TO BUILDING MATERIALS DURING REFURBISHMENT OF HERITAGE MOSQUES

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Abstract

Refurbishment work is more complicated than new projects because it involves dismantling, demolition, removal, and new installation. The jobs apply to different stakeholders and the public within the vicinity of the projects or using the spaces such as in a Masjid (Mosque). The stakeholders are vulnerable to health and safety risks exposure due to unknown risks and limited information about the project. Scientific findings showed that human health and safety are at risk of being exposed to dust, fumes, gases, vapours, and toxic building materials. There are potential hazards due to an accident that causes harm or adversely affects the health and safety of the stakeholders. This paper discusses the potential risks to health and safety from building materials for future heritage mosques refurbishment projects. Visible observations were selected as the research method and were carried out on three sites that are listed as heritage mosques in Klang, Selangor. Hazardous materials will be identified from the inspections. Findings revealed that there are potential risk exposures due to materials, construction, and the working environment. Hence, there is a need to consider risk management before any refurbishment works. The findings should be informed to the stakeholders as they have the right to know.

Keywords*: Health and Safety, Material, Mosque, Refurbishment, Risk*

INTRODUCTION

"Masjid" or "mosque" (as used in the architectural terminology) is a building used by the Muslims for congregational prayer. The word "Masjid," generally used in Arabic literature, refers to any place of worship in any religion (Rasdi, 2014). A masjid also serves as an important multifunctional community center for learning, training, upholding justice, settling disputes, socialization, funeral rituals, and many more. The mosque is integral to the development of the Islamic community, culture, and civilization. Maintenance, repair, and refurbishment are needed to tackle building fabric's inevitable decay and deterioration because of climatic conditions, wear, and tear made by users, neglect, or other threats. Growing Muslim

population has caused space constraints in many mosques. The evolution of Malaysian mosque architecture, from its traditional timber prototypes that related it to the large family of Southeast Asian vernacular architecture, to the unique and independent styles that emerged after independence, all the way to the colourful, eclectic developments in the 21st century, exhibits a rapid transformation of political thought, aesthetic values, and socio-economic identity (Amir, 2017). Mosques are buildings that are frequently used and require some form of refurbishment after several years. Refurbishment work is conducted by adding more spaces or achieving better sustainability standards (Ankrah & Ahadzie, 2014), and maximizing energy consumption (Meeus et al., 2012; Passer et al., 2016). However, refurbishment works involve much unknown information (Isnin, Ahmad & Yahya, 2012) due to incomplete information on existing building data and drawings. Ranasinghe et al., (2021) described building refurbishment as 'safety-critical projects' as it can bring harms to the stakeholders physical. Published studies on existing literature indicate that refurbishment projects are significantly riskier than new builds (Reyers, 2001). It is stated in (Ranasinghe et al., 2020) that the risk is due to unavailable information before execution, unanticipated discoveries during construction and conducting construction in practical environment Issues related to health and safety risks from building materials during refurbishment projects are often underestimated and studied. This paper discusses the findings from three heritage mosques and identifies potential risks for future refurbishment work. With the advancement in technology, there are more unknown exposures, especially from newer materials. Refurbishment at heritage mosques involved various stakeholders such as the mosque committee, consultants, contractors, workers, and the community. They have the right to know about risks and how to manage them. The information should be shared, and it has too also been comprehensible.

LITERATURE REVIEW

Risk of Health and Safety in Mosque Refurbishment Projects

Refurbishment projects involve dismantling, partial demolition, and installing and upgrading new finishes and more complicated materials (Ali et al., 2009). Many unknown, unexpected, frequently undesirable, and often unpredictable factors (Akintoye & MacLeod, 1997). There are many unknown, unexpected, frequently undesirable, and often unpredictable factors when a building undergoes refurbishment project (Akintoye & MacLeod, 1997). It will be riskier if the building is still being used. Scientific findings showed that human health and safety are at risk of being exposed to dust, fumes, gases, vapors, and toxic building materials. There are potential hazards due to an accident that causes harm or adversely affects the health and safety of the stakeholders. Health refers to protecting human bodies and minds from illness resulting from exposure to materials, construction processes, or proceeding used in the workplace. In contrast, safety protects people from physical injury (Hughes & Ferret, 2008) with no danger of causing an accident.

The Risk from Exposure to Building Materials

Building material substances or chemicals have the potential to affect human health. Most building materials are reasonably safe until they are disturbed by construction acts, fire, or water damage. The hazards from these building materials depend on the content of hazardous substances that could penetrate a human from various routes of entry or contact. It takes place after it has entered the body through multiple ways of access. The risk occurs through inhalation (mouth or nose into lungs), ingestion (mouth into the stomach), injection (cuts into the skin), and dermal absorption (skin membrane). The results can be harmful to human health in various ways, including respiratory diseases such as asthma, heart diseases, cancer, brain damage, or poisoning. Building materials may be dangerous when they become degraded, disturbed, or

airborne. Some building materials emit chemicals made or by contributing to the dust as materials disintegrate. Common building materials that have been published in research are asbestos, lead, polychlorinated biphenyls (PCBs), Volatile organic compounds (VOCs), synthetic mineral fiber (SMF), and others. Formaldehyde, a group of volatile organic compounds used, for example, in plastics and other polymeric materials, can remain in the environment for a long time, becoming absorbed in dust or soft furnishings and released later. Radioactive elements like radium, uranium, and thorium can be found in sandstone, concrete, brick, natural stone, gypsum, and granite. It has a variety of carcinogenic effects. These naturally occurring elements can break down or decay into radioactive radon gas. In most instances, the materials' contribution to indoor radioactivity is small compared to soil radon gas; however, construction products from industrial waste can have significant emissions. Inhalation of dust and gases can trigger a variety of responses. The possible health effects can be toxic, irritant, or sensitizing (United Nations Centre for Human Settlements (Habitat), 1997). Harmful effects may be acute, resulting in direct damage to organs, or chronic, causing, for instance, cancer, genetic harm, or congenital disabilities. Irritant effects affect the skin, or through inhalation, can cause discomfort or damage to the mucous membranes, the nose, lungs, or eyes. Allergic products include a variety of sensitivities, for example, asthma, rhinitis, or eczema. In addition, dermal exposure occurs due to splashes or spills during the application, mixing and loading, or contaminated surfaces. Organic solvents and metalworking fluids are considered to be important contributors to occupational ill-health. Prolonged or repeated contact with wet work can be harmful to the skin. This effect can be enhanced by the presence of other irritants (e.g., in occupations such as glass cutter or metalworking). Adverse health effects are dependent on several factors of exposure, such as:

1. The type of chemical.
2. The amount or dose
3. The duration (how long did exposure occur).
4. The frequency (how many times the person was revealed).

The occurrence of adverse health effects can depend on the way the chemical enters the body. Some chemical substances rapidly absorb through the skin while others may not. The toxicity of the chemical affect health, and the amounts absorbed by the body determine it. The effects of exposure from hazardous building materials may be slow, cumulative, irreversible, and complicated. Some of the identified health hazards associated with building materials are well documented, and there are safety and health programs to prevent the effects. However, there are still many unknown effects and suitable remedial measures, especially for newer materials subjected to future research.

It should be noted that research has demonstrated that harmless materials may be found to be hazardous and damaging in the future with continuing advances in science and medicine. According to Hayder & Nangkula (2019), authorities should pay more attention to providing enough regulations and standards to generate healthier spaces that respond to users' needs at the mosque number of the Islamic community, culture, and civilization. Maintenance, repair, and refurbishment are needed to tackle building fabric's inevitable decay and deterioration because of climatic conditions, wear, and tear made by users, neglect, or other threats. With a growing Muslim population, a mosque also faces space constraints. The evolution of Malaysian mosque architecture, from its traditional timber prototypes that related it to the large family of Southeast Asian vernacular architecture, to the unique and independent styles that emerged after independence, all the way to the colorful, eclectic developments in the 21st century, exhibits a rapid transformation of political thought, aesthetic values and socio-economic identity (Amir, 2017). Mosques are buildings that are frequently used and require some form of refurbishment after several years. The reasons for refurbishment are adding more spaces or

achieving better sustainability standards (Ankrah & Ahadzie, 2014), and maximizing energy consumption (Meeus et al., 2012; Passer et al., 2016). However, refurbishment work involves unknown information (Isnin et al., 2012) due to incomplete information on existing building data and drawings. Published studies on existing literature indicate that refurbishment projects are significantly riskier than new builds (Reyers, 2001). Issues related to health and safety risks from building materials during refurbishment projects are often underestimated and studied. This paper discusses the findings from three heritage mosques and identifies potential risks for future refurbishment work. With the advancement in technology, there are more unknown exposures, especially from newer materials. Refurbishment at heritage mosques involved various stakeholders such as the mosque committee, consultants, contractors, workers, and the community. They have the right to know about the risks and how to manage them. The information should be shared, and it also has to be comprehensible.

METHODOLOGY

To identify the materials used within the buildings, visible observations are applied within the study. Three mosques built in Klang districts were surveyed and inspected in this study. The selection of the mosques was based upon key criteria such as:

- listed as Klang District heritage site under "House of Worship" category,
- the area is surrounded by community,
- year built (between 1876 until 1910).

The selected mosques are as follows:

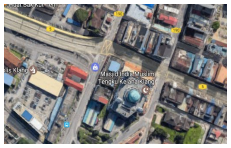
- Masjid Al-Muhsinin Kg. Sungai Kandis
- Masjid Kampung Dato' Dagang Kg. Jawa
- Masjid India Muslim Tengku Kelana

From the data obtained, discussion will be made according to the three (3) phases of refurbishment which are:

- Phase 1: During survey and inspection of building and premise
  Inspection of building and premise is needed to understand the building and maintenance needed. This will assist in the refurbishment process later. All problems related can be highlighted before executing refurbishment process. Therefore, hazardous materials can be identified through this process.
- Phase 2: During demolition, dismantling, and salvaging materials for reuse and recycling
  Before construction, all materials may be dismantled. These materials can then be reuse or recycle in refurbishing the building. Without proper procedure, hazardous materials may endanger both stakeholders and the environment.
- Phase 3: During construction.
  Refurbishment will be conducted in a confined space since the building has already been constructed. Therefore, exposure to certain building materials that produce fume and dust may affect the stakeholders.

RESULTS
Case Study - Heritage Mosques in Klang

Table 1
Information on Heritage Mosques inspected

Name of Mosque	Masjid Al-Muhsinin Kg. Sungai Kandis (M1)	Masjid Kampung Dato' Dagang Kg. Jawa (M2)	Masjid India Muslim Tengku Kelana (M3)
Building photo			
Aerial view (reference from Google maps)			
Year built	1906	1876	1910
Address	155, Jalan Sungai Kandis, Kampung Sungai Kandis, 40470 Shah Alam, Selangor, Malaysia	Batu 1 1/2, Jalan Kota Raja, Kg. Jawa, 41000, Klang, Selangor, Malaysia	Lot 32, Jalan Tengku Kelana ,41000, Klang, Selangor, Malaysia
Capacity	1,500 pax	1,000 – 1,500 pax	3,300 pax
Surrounding area	Residential	Residential, cemetery, school and shops	Shops, public buildings
Identified hazardous materials	Asbestos roof sheets, plaster ceiling, VOC, PCB, SMF, fungal spores and mould, M&E equipments	Asbestos roof sheets, plaster ceiling, VOC, PCB, SMF, fungal spores and mould, M&E equipments	Plaster ceiling, VOC, PCB, SMF, fungal spores and mould, M&E equipments

DISCUSSION
Identified Risks During Refurbishment Works for Heritage Mosques

There are many possible factors when refurbishment projects proceed from the visual inspections carried out at the three sites. The discussion will be based on three main phases of work for future refurbishment projects.

A) Phase 1: During Survey and Inspection of Building and Premise

i) Risk 1:

There are asbestos roof sheets for ancillary buildings at M1 and M2. There are also other identified materials such as formaldehyde, PCB, SMF, VOC, and others. In future refurbishment projects, a survey on existing building conditions should include the

identification of hazardous materials. Previously, only asbestos was widely known as a material that causes lung cancer and malignant mesotheliomas, pleura cancer, lining the lung and stomach (Hueper, 2013). However, many other chemical building materials have been found to cause high health hazards (Curwell et al., 2002; Dürkop et al., 2007; Kim & Yu, 2014).

ii) Risk 2:

Unfortunately, existing documents related to the mosques are incomplete. Some of the information is not updated. There is also limited access to inspect the building condition or materials used as the elements are concealed or not accessible. If the appointed contractor has limited working experience and knowledge as well as lack of communication, a healthy and safe working environment in the construction sites will be affected.

Inspection of records or reports can be very useful to understand the building and its maintenance needs. Any available examination or condition reports or structural assessments will highlight any chronic problems or areas that should be monitored. Any unanticipated problems could lead to various issues. According to Anumba et al. (2004), inadequate planning and improper demolition or construction methods can cause injuries and create an unsafe site. It is vital to identify possible risks on effects of exposure to building materials.

B) Phase 2: During Demolition, Dismantling, and Salvaging Materials for Reuse and Recycling

At this stage, stakeholders are exposed to dust and fume inhalation, dermal contact, or skin abrasions. Removal and improper collection of waste, unwanted materials, and materials to be recycled and reused may cause potential pathways for chemicals to reach the soil and groundwater.

i) Risk 1:

Demolition and dismantling work produced dust, debris, and odors. The unwanted materials and trash such as bricks, gypsum walls, ceiling sheets, carpets, tiles, framing for ceiling, doors and windows, broken glass, floor tiles should be collected in proper waste containers.

ii) Risk 2:

Electrical and mechanical items such as galvanized iron trunking, conduits, light fittings, lighting casements, lamps, thermostats, and light switches containing mercury; batteries from exit signs, emergency lights, and smoke alarms; lighting ballasts. Broken fittings should not be dumped together with other building wastes. Light tubes contain mercury, and ballast has PCBs. They are considered safe if unbroken, but there is a potential environmental impact for disposal. Ballast, for example, will release dioxins and furans if broken and can cause skin contact or ecological effects.

iii) Risk 3:

Some of the construction debris will also include materials contaminated with fungal spores and mold due to water leakage, chemical or animal droppings, or insect attacks. Microbial contamination caused by water damage and condensation is considered hazardous material (Gravesen et al., 1999; Jack Dwayne Thrasher, 2016). Any building wastes should not include hazardous materials.

iv) Risk 4:

Building wastes should be dumped at a properly designated landfill area. All the case studies contain gypsum plasterboard or drywall. The main ingredient is calcium sulfate that is classified as non-hazardous. In the United Kingdom, under the new regulations, waste containing gypsum or calcium sulfate can no longer be mixed with biodegradable waste at a standard landfill site (HM Revenue & Customs, 2015). A mixture of gypsum with other biodegradable waste will release hydrogen sulfide gas that is toxic, colorless, flammable gas with a very distinct foul odor similar to rotten eggs. Exposure to hydrogen sulfide can lead to adverse health effects such as breathing difficulties, discoloration of the skin, and eye irritation. Building waste, unwanted materials, materials to be recycled and reused should be segregated. The container for hazardous material should be lined with plastic sheeting to prevent leaking or spilled material. Any incompatible hazard items (e.g., oxidizers away from flammables) must be stored separately using proper containment before demolition or refurbishment (Kim & Yu, 2014). Workers and users of the buildings are exposed to various hazardous substances, some of which are known to cause fatal disease. Workers are advised to wear any approved disposable respirator as a minimum or hand gloves following Occupational Safety and Health (OSHA) Respiratory Protection standard. Plastic sheeting can be applied to the floor, ground, or other applicable surfaces to prevent contaminating the building interior or exterior from dust generated by the work. Placing the containment area under negative air pressure is also an effective tool. It is recommended that the site should install ventilation or engineering measures before work begins.

c) Phase 3: During Construction

At this stage, stakeholders are exposed to inhalation of dust and fume, dermal contact, or through skin abrasions, eyes irritation, or ingestion.

i) Risk 1:

Workers will be working in a semi-confined space with limited ventilation, access, and inappropriate protective equipment. They will use different materials, equipment, different processor conditions. It is advisable to select tools and work methods that generate the lowest possible dust volume.

The sites will usually be congested with different activities, materials, equipment, with limited exit and entry points. Workers are generally required to work extra hours to complete the given tasks. They have an elevated risk of developing different types of illness such as cancer, asthma, skin disease, and other terminal illness due to occupational exposure. Toxic exposures often involve low-level, long-term effects that the victim or even the healthcare practitioner is not easily identified. The sufferer of exposure may continue working without realizing the slow poisoning and damage that contribute to chronic and debilitating diseases. Long working hours, not enough rest, and poor affected health conditions may result in loss of concentration at work and fatigue, increasing the risk of accidents. It may cause higher sickness absence from work and incur higher medical bills (Sirajuddin et al., 2001). Young children and older people who frequently visit and use the mosques are more likely to develop health problems from long-term exposure to high dust levels from the refurbishment work.

ii) Risk 2:

Refurbishment projects are often carried out by small and medium construction companies. Malaysian contractors often engage unskilled migrant workers to minimize construction costs (Rampal & Nizam, 2006). The companies may lack resources to provide proper construction

and safety equipment and lack training provisions (Keng & Razak, 2014). They have lower safety and health standards compared to those in European and Scandinavian countries.

iii) Risk 3

Secondary victims such as family members or friends of the workers can also be affected by harmful dust left on the worker's clothes brought home (Sen et al., 2002; Whelan et al., 1997). There are few studies on workers' health effects from prolonged exposure to building materials substances. Although Malaysia has a very good law on health and safety policies, it lacks enforcement from the authorities (Shim, 2006). General construction labor in Malaysia is still cheap and easily replaceable. Construction workers seldom know about their rights at workplaces. The refurbishment project is usually short. Thus, the jobs may be on a temporary basis not only for migrant workers but also local workers. The situation makes their livelihood uncertain in terms of pay and living. These workers often neglect to maintain their health, safety, and well-being to sustain their jobs.

Standards, Regulations, and Information

There is a large body of literature on the potential adverse health effects of exposure to chemical hazards in a laboratory, construction waste, particularly from landfills, and incineration but little to potential problems resulting from exposure during construction activities. In Malaysia, the Occupational Health and Safety (Use and Standard of Exposure of Chemicals Hazardous to Health (USECHH) Regulations 2000 for the use and standard exposure of chemicals hazardous to health is available, but studies were unknown on its application to the construction project. Furthermore, there is a minimal study on the implementation of safety and health system in refurbishment projects. There is less information on workers' awareness and knowledge on possible exposure to building materials and limited study on the effects from exposures faced by refurbishment stakeholders during the demolition and dismantling processes (Isnin et al., 2012a). Based on previous studies, information on occupational exposure to hazardous materials in construction can also be described as outdated and incomplete.

Rights-to-Know and Enforcement on Personal Protection

Stakeholders of any refurbishment projects have the "right-to-know" about the risks to health and safety. Available information on the dangers of materials and the effects are not available on site. Where can they obtain the information on the building material substances and the consequences? Most building materials often have product safety information sheets prepared by manufacturers known as Material Safety Data Sheet (MSDS). MSDS contain information on toxicity, first aid, personal protection controls, storage and handling precautions, spill and leak cleanup, disposal practices, transportation, biological data, and reactivity data. Based on MSDS, a section on Precautionary Statements recommends measures to minimize or prevent adverse effects from exposure to a hazardous chemical or improper storage or handling. However, many MSDSs have inaccurate or missing information (Isnin, et al., 2014) and are quite difficult to be understood by non-English speakers.

CONCLUSION

Workers need to know about the hazards of the materials, including the minimum requirements for safe use and exposure control to protect their health. They have the “right to refuse” a job deemed unsafe. Enforcement exercise on health and safety requirements needs to be implemented. This protects the workers and other stakeholders, especially people using the mosque who are exposed to the risk. Building codes, material production, and processing

regulations should consider the resources that may contribute to indoor contaminants and pollutions. There is a need for information on the risks of building materials to refurbishment projects that also involve the public. The information should be easy to understand and could assist them in implementing risk management. The available and accessible information is a response to the "Right-to-know" legislation. This will enable stakeholders to prescribe a management system according to the stipulated regulations and acts to reduce risk. The findings of this study might contribute to help the stakeholders in making decision whether to undertake refurbishment project and improving their risk management plan.

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