

# Classification of Potential Risk Factors through HIRARC Method in Assessing Indoor Environment of Museums

Syahrin Neizam Mohd Dzulkifli<sup>1</sup>, Abd Halid Abdullah<sup>1\*</sup>, Lee Yee Yong<sup>2</sup>, Mohd Mahathir Suhaimi Shamsuri<sup>3</sup>, Zawawi Daud<sup>1</sup>

<sup>1</sup>Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia

<sup>2</sup>Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

<sup>3</sup>Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia

Received 12 April 2018; accepted 19 November 2018, available online 29 December 2018

**Abstract:** Museums were established in Malaysia more than a hundred years ago. Since the year 2005, Malaysian government has discouraged constructing new purposely built museums in favour of refurbishing historic and old buildings to function as adaptive reused museums. Commonly due to insufficient ventilation, fully mechanically ventilated museums can pose critical indoor environmental issues that may lead to health hazards and risks among employees and visitors. Thus, the purpose of this study is to determine the potential risk factors within the museums based on indoor environmental criteria. This potential risk factors are resulted from the 'Potential Risk Categories', which have been developed by adopting the established Hazard Identification, Risks Assessment and Risk Control (HIRARC) Method. Based on the assessment of four main indoor environmental criteria in the Potential Risk Categories, it was discovered that 8 out of 24 museums are in the range of medium potential risk, while the rest of them are in the range of low potential risk. The 'Potential Risk Categories' is important for assessing indoor environment at the museums whereby the most critical risk could be assessed, and then suggestion could be provided to minimize the potential risk within the spaces inside the museums.

**Keywords:** Indoor environment, Museum, Adaptive reused museum, HIRARC method

## 1. Introduction

Indoor air quality issues are not new in Malaysia. Nevertheless, the lack of study, data and local regulation becomes one of the major contributions towards this problem especially with the non-industrial sector [1, 2, 3, 4, 5]. Air pollution is a particular problem in historical buildings such as adaptive-reused museums, because they were not originally built to exhibit and protect art objects in a sustainable way [6]. Due to insufficient ventilation within these environments particularly in tropical regions, people are exposed not only to humid and hotter indoor spaces [7, 8] causing occupants' discomfort but also to pollutants emanating from a wide array of sources that creates indoor environmental problems which could affect their health [9, 10].

The museums were established in Malaysia more than a hundred years ago. Since the founding of the first museum (i.e. The Perak Museum) in Taiping in 1883, more than 100 museums have been set up in this country [11]. They are managed by various government agencies from federal to the state levels [12]. The museums in Malaysia are constantly challenged by poor public perception as being a dull repository and being queried from financial providers based on the museum's performance in generating profit for the nation [13].

Thus, improvements are necessary to attract more visitors and provide a healthy environment inside the museum.

Since the year 2005, Malaysia has encouraged refurbishing historic and old buildings to serve as adaptive reused museums instead of constructing new purposely built museums due to several reasons such as the economic crisis, land limitation and sustainable issues [14]. Furthermore, there are about 56 historical adaptive reused museums which were not originally built for the purpose of being a museum, where few studies have been conducted on the quality of their indoor environment in Malaysia [15]. These museums can be divided into two types, namely a purposely built museum, and an adaptive-reused museum where the building was originally built for other functions such as residential, office, institution, etc. For adaptive-reused museums in particular, balancing the requirements of the building fabric, the occupants and the contents, while meeting desired environmental criteria can be extremely difficult. Thus, it is even more crucial for museums that require a specialized and strict building control systems where thorough investigation of indoor thermal and air flow conditions using either field study or computer modelling and simulation are necessary [16, 17].