

Assessment of Mould Growth for Library Buildings in Tropical Climates

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Abstract. This paper attempt to give a brief insight into the importance of studying mould growth in library building that relates to human health and causes of material deterioration to library materials. It's significant to conduct this research because no similar study has carried out for a library building in Malaysia. Recent literature on the topics reviews to gain insight into developing a theoretical framework and research method. Likewise, the study also supports through pilot study questionnaires with 30 respondents from two different university libraries. The finding revealed to further investigation and mould growth assessment to be conducted that useful in protecting library materials and users health effects through environmental control.

1 Introduction

This paper presents part of current PhD research study. The aim of this paper is to report a pilot study on assessing mould growth and its effect to the library users in two different universities in Malaysia. To achieve the aim of this study, it combines a literature review with a questionnaire survey and analysis. The major finding drawn from the survey was the important for the researcher to complete assessing mould growth and conducting investigation on mould growth and its relation to the health effect of the users. This paper has three main sections. First, a literature review of mould growth in library building and environmental factors in library deterioration problem. Second, the proposed theoretical framework in assessing mould growth in building that consists of four important steps. Third, the adoptions of the first step in assessing mould growth in the library building and it's finding based on the pilot study. This paper intends to understand assessing mould growth in library building that can lead to the better environment of the users.

2 Literature Review

The library is the place known as the first point of knowledge gain and in building typology it is categorized as academic building. It is an important to all students, lecturers and others have to pass through this area to gain the information and knowledge besides attending to the class. The library is also used by the public to seek knowledge as well as daily life. The important parts are libraries are the place which conserve, collects and record of human knowledge that useful for the future [1].

Consequently, it becomes focus agenda and service mission of all Universities in the world to deliver with effectiveness and efficiency in producing the best library service. Nowadays modern libraries consist of many books such as historical books that are centuries old, newspapers and magazines, maps, audio visual materials, photos, multimedia items and others [2].

However libraries are favourable environments for the growth of mould. Mainly library collections are often composite stuff. Frequently composing the library building made from many types of material [3]. As stated in Aerobiological Engineering Handbook, libraries generally require severe control over indoor air conditions. Acceptable of relative humidity and temperature should be highlight in term of reducing the rate of deterioration of books and other materials.

It became serious as library must have the characteristics to become avoiding from noise for example the used of carpet and other materials. The materials stored in libraries may be a source of allergens and the nutrient source for microorganisms, especially fungi [4]. The biological reason is related with attack of a material by a living organism, such as bacteria, fungi or insect infestation. In these circumstances measurements of mould growth assessment needed for efficiency and users satisfaction of library environments.

2.1 Biology of Mould

Mould is part of the natural environment and microscopic subset of the fungi kingdom. It grows indoor and outdoor of buildings. Moulds reproduced by the spores which are tiny and invisible to the naked eye and float through outdoor and indoor air. According to Occupational Safety and Health Administration (OSHA) more than 1000 species of mould found in United States with more than 100,000 recognised species worldwide.

Moulds reproduce and grow rapidly. They grow with acceptable of moisture, nutrient, temperature and air [5,6,7,8]. Mould can cause material stain or discolored and overtime can cause wood rot and structural damage and sometime can detected by a musty odors [9]. It also can cause allergy react and illness [10]. If we having an experienced on this probably we faced of health risk [11]. Mould grows on dead material and commonly visible growth as various fungi. It's usually seen as fluffy spots on the surface of materials such as textiles and materials.

2.2 Growth Condition

There are several reasons for the growth and survival of mould. Mould germinated with necessary conditions such namely a) moisture; b) temperatures; c) relative humidity; and d) nutrients.

2.2.1 Moisture Conditions

Moisture or water is the key factor of mould growth. Water can occur in different form and it originates from different sources. Moisture can be performed from leakage of plumbing [12,13] rainwater or groundwater leaking into the enclosure, condensation [14,15] structural damage and high humidity levels.

2.2.2 Temperatures Conditions

The temperature could be 10-35°C with optima of 20°C and above [16]. Mould also favour with temperature between 59-86°F (15-30°C) and there are varieties of mould will grow outside of these limit [17,18]. While temperature below 10°C inhibit spore germination and above 50°C will dehydrate and kill fungi within a few hours [16].

2.2.3 Relative Humidity

Humidity measurements involve and relative humidity. Complete humidity is measured in term of the mass of water vapour per unit volume of natural air [18]. According to EPA [19] maintaining humidity level below 60% and ideal between 30-50% significantly can reduce the chance to mould growth. In order mould grow and spread it must have a food source and moisture. It has a greater chance of developing problems with IAQ in the building when humidity is greater than 50% [20].

2.2.4 Nutrients

The nutrients of mould growth includes carbon, hydrogen, oxygen, nitrogen, sulphur, potassium and magnesium [21]. In the library the book collections are favourable for mould growth because they made from organic material such as paper, starch, leather and cloth and its ideal substrates of mould growth.

2.3 Mould Is Associated With Human Health Effects

Mould exposure is one of significant cause in Sick Building Syndrome (SBS). Sick Building Syndrome is a combination of ailments associated with an individual's place of work or house. Mould damage not only can pose a serious threat to library collections but it also can harm to peoples' health. Small amounts of mould growth in workplaces are not a major concern but no mould should allowed to problems for some people [9]. Specific types and concentrations of mould in damp indoor environment can cause respiratory irritation to human health [22].

Coughing, wheezing, and nasal congestion may as a signs and symptoms of disclosed to the mouldy environment [15,23]. It could be having symptoms such as sneezing; irritation of the nose, mouth, or throat; nasal stuffiness and runny nose; and red, itchy or watery eyes. Inhaling or touching mould or mould spores may cause allergic reactions to certain individuals. They can be immediate or delayed [19].

Many people have no reaction when exposed to moulds. It's depends on their age, fitness and the species of mould itself. However according to [9] the risk group could be infants and children, elderly people, pregnant woman and individuals with respiratory conditions or allergies and asthma. Exposure in different environments and for variable durations makes the accurate determination of exposure challenging.

2.4 Environmental Factors in Library Deterioration Problem

Fungi not only have adverse effects on health but also cause great damage to buildings, the wood-rotting fungi being destructive to (wooden) building structures. Mould spores also attracted to paper, starches, glue, gelatine, and leather. According to the National Library of Australia (1) deterioration of library materials is one of the major crisis facing libraries throughout the world. The rate of book decay is high in tropical countries where reasons that aggravate weakening are at ideal [1]. Wessel [18] classified the environmental factors in library deterioration problem as table I below.

Table 1: Environmental Factors Important In Library Deterioration Problems

No	Factors	Causes
1	Atmospheric	Pollutants – Particulate Matter (Dust, dirt etc)
		Gases – Acidic Components (Oxidants)
		Normal Constituents – Water
2	Radiant Energy	Light, Heat and Other radiation effects
3	Biological	Microbiological Agents – Fungi, Bacteria, Actinomycetes
		Macro biological Agents – Insects, Rodents

3 Result From Pilot Study

A questionnaire survey approach was used to collect a primary data of this pilot study. The questionnaires were administered to 30 respondents from two different universities in Malaysia. Seventeen (17) questionnaires were returned and analysed for this study with a response rate of 57%. The purpose of this pilot study was to investigate the current state of mould growth resulting impact on health, environment, material and archive in the library.

A quantitative analysis using SPSS was used to evaluate the data collected from a questionnaire survey. The question developed based on the step one of mould assessment which is to gather as much information as possible about the situation and to create an assessment plan. The study population comprises the users who are the librarian staff, administrative and management staffs that working in the library building.

The questionnaire survey consists of 29 questions and divided into four sections; these are demographics, health experience, library observation experienced and employee opinion.

3.1 Demographic Survey

It reveals that a huge number (57%) of the participants were women and (36%) were men. It was discovered that, 14% of the participants were the deputy chief librarian and senior librarian while (36%) were assistance librarian and other.

It was found that many (43%) of the respondents were spending their time working in the office, (14%) each recorded work in information reference, IT section and other places while (7%) worked in circulation center and open access collection. From the survey it was found that (71%) are working more than 8 hours and the rest (21%) working between 6 to 8 hours and (8%) work between 4 to 6 hours. The length of service distributions indicated that (36%) have been working more than 15 years, (11%) have been working between 11-15 years, whilst 42% have been worked below than 7 years.

3.2 Health Experience

In general, it shows that a large number (65%) of the respondent were in towards to excellent condition whilst (21%) recorded towards poor condition. Table II shows the percentage of the respondents with the following symptoms in the last four weeks.

Table 2: Symptom Experienced

No	Symptom	Percentage (%)
1	Headache	50
2	Allergy	42
3	Coughing	33
4	Eye irritation	33
5	Dry skin	33
6	Runny nose	25
7	Tearing eyes	25
8	Short of breath	8
9	Blocked nose	8
10	Dark circle under eyes	8
11	Nose rubbing	8

The survey revealed that 50% of the respondents seen the doctor because of the symptoms whilst others have not seen the doctor. The length of the symptoms has been recovered indicated that 50% have been recovered from the symptoms more than a week, (29%) recovered it within overnight and (7%) of the respondent felt that the symptoms experienced permanently. The majority of the respondents (86%) agreed that their health interfere with the library condition. This is an indicator that quality environment of the workplace has strong relations with the user’s health and it is important for the researcher to study on the effect of mould growth.

3.3 Library Observation Experiences

The survey revealed that most of the respondents (77%) felt that the library is too cold, (54%) found the library in a dusty condition, (31%) been recorded the library environment with air dry and seem stuffy and (23%) of the respondent have experienced unusual odors and the temperature.

The survey also found that 71% of the library are being carpeted with the intention of acoustic performance. It is also found that (75%) of the respondents stated that they have an experienced of water ingress from the roof leaks, (38%) of the respondents faced plumbing leak incidents and (13%) of respondents confirmed that water leak through defective windows. The findings also revealed the users have found the signs or the symptoms of mould growth within the library building structure and fabrics including books and library archives.

From the analysis, the highest percentage of mould growth (55%) found in book collections, (45%) on the carpet, (36%) appeared on the ceiling, (27%) found on the shelf or stack and (18%) visible on the floor. It is not surprising that books have been recorded as the place of visible mould growth. Further, it is interesting that the respondents rated higher on the symptoms that marked mould growth on the books which is (58%) found it smelly.

Figure 1 pointed out the percentage of mould growth symptoms that been observed by the respondents on books in the library building based on the users experienced.

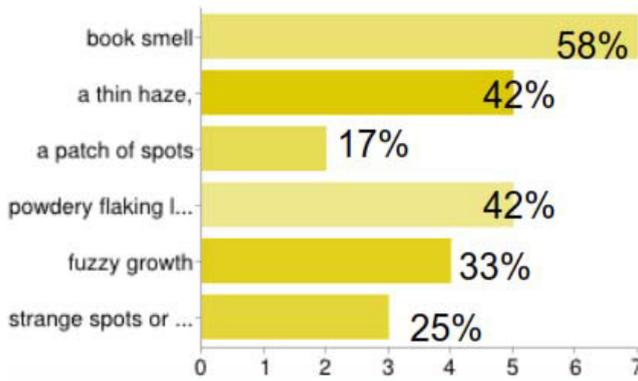


Figure 1: Mould growth symptoms on books in the library

Furthermore, the user perception of the quality working environment that relates to the negative impact on their work performance revealed that the majority of the respondents (72%) agreed that quality of air have a strong effect on their work performance. These factors have been related to the environment indicators such as if the air is humid or dry, smelly air, room temperature including users control over the ventilation system provided.

3.4 Employee Opinion

As anticipated, most of the respondents agreed the importance of Indoor air-quality (IAQ) in the library building. Furthermore, (65%) of the respondents agreed that library are risky for the mould growth due to the condition and its operatives. In addition, (79%) of respondents agreed that exposure to mould will effect to their health. For the books that become a primary collection of the library, most of the respondents (79%) agreed old book have the potential and more risky to the mould growth compared to the new book. The users also suggested that old books or archives are valuable material that we need to protect from deterioration. The users (79%) also agreed that mould also been identified as harmful to the library environment and physical condition.

4 Conclusion

This paper presents the finding on the step one of assessing mould growth in a library building in Malaysia. Mould growth can occur from water damage, condensation, leaks, or even the mere presence of high humidity. A further assessment in laboratory is required to confirm on the possible types and species of moulds in the library. This also required a depth understanding of the relationship between the mould growth, its causes and effects to the built environment and its occupant.

The mould growth can be identifies and can be useful for benchmarking and creating a comparative database for the future. This will improve library design and maintenance including the prevention of mould growth in the library building. The paper concludes that there is a need for research on the mould growth in a library building and suggest the researcher to complete the steps in assessing mould growth.

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