



The Solution of Paint Coloring Causes by Sun Radiation on External Wall

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ABSTRACT

There are many different types of building designs available today. As a result, the focus of the design is on the quality of the building's paint. The unique use of paint, as well as the quality and durability of the paint will increase the visual value of the building. Thus, the researchers believe that the fading of the paint color on the exterior walls of the building is caused by a natural factor which is the sun's rays. The researchers have decided to conduct an in-depth study of paint fading as well as potential methods to overcome and control the problem produced by sunlight on paint. This experimental study aims to identify a solution for the fading paint color caused by sun radiation on the external wall of the building. This study used two approaches to examine paint color fading, including a literature review and interviews with a panel of experts. This study also focused on solutions that can be implemented to meet the objective of the study, which was to study the effects of sun radiation on paint fading on the external walls of the building, determine the actions that need to be taken to reduce fading on the external walls and recommend solutions of retaining the paint coloring external wall of the building.

1. Introduction

The effect of color on the exterior walls of buildings produced by sunlight is shown in this study. Therefore, researchers found that sun radiation has caused fading paint. The color used to paint the exterior of the building not only adds to its visual appeal but also acts as a barrier between the natural elements, especially the sun's rays. As a result, the sun radiation has affected the color of the paint on the exterior walls of the building. According to Sanmartín & Pozo-Antonio (2020) [1], some damage can be caused by the sun's rays on the exterior wall covering such as paint fading.

In this study, the researchers investigated various issues of paint color deterioration caused by sun radiation on building exterior walls. We hope to develop an effective and sustainable way to maintain the best features of exterior paint by analyzing the extent to which the effects of sun radiation cause fading paint and propose a solution for retaining the coloring on the external wall. This research can help in architectural preservation, especially exterior paint for residential structures.

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According to Abdullah *et al.*, (2022) [2] talking about the effect of the color of the exterior walls of the building two sets of experiments were conducted in 2011 in June at UTM Skudai in Malaysia where the first experiment studied different paint colors, including white and yellow, and brown to exterior walls of the building while using dark brown-orange, and green on the roof of the building. The results of the study show that the lowest surface temperature on the white color at the maximum hour of the sun is 35.4° C while the orange color on the roof surface records the lowest temperature under the sun. Busy time and is 37.4 °C. Therefore, we can see that the choice of paint color also affects the degree of heat of the surface temperature. Therefore, the heat effect caused by sun radiation has led to an increase in the temperature on the external wall as well as causing fading paint.

2. Literature Review

2.1 Paint Colouring of External Wall

The external wall paint is something very different compared to the paint used on the walls inside the building. This exterior paint will be exposed to sunlight and rain as well as rapid temperature changes. This will cause deterioration of the paint. This is also affected by temperature changes that cause expansion and contraction of the outer part of the wall. If it is not adjusted it will cause defects in the paint. Exterior paint is also created with a faster drying process than interior paint. This is to enable the painting process to be carried out in any temperature condition. According to Chai *et al.*, (2014) [3], in 220 case studies, it was found that painted surfaces have various factors that affect their durability. These factors can be grouped into three groups in relation to:

- The quality of the materials used,
- Quality implementation and
- Environmental exposure conditions.

Paint coloring of external walls also considers severe conditions due to increasing environmental pollution, exterior wall paint should also play an important role in protecting buildings from air pollution [4].

2.2 Definition of Sun Radiation

The sun is the center of thermonuclear processes and produces a large amount of energy emitted by the sun, which is solar energy or solar radiation. Despite the great distance between the sun and the earth, the amount of solar energy that reaches the earth is large. It is the earth's main source of natural energy and by far [5]. According to Widén *et al.*, (2019) [6], the definition for sun radiation is the overflow of the Sun's energy and the natural seasonality has set the limits of human life and the prosperity of society and growth, controlling the change of seasons. However, the direct use of solar radiation for specific purposes such as heating and providing power, made its appearance relatively late in history. Other than that, Sun radiation is an electromagnetic wave that moves from the sun to the earth. Global solar radiation is the quantity of shortwave radiant energy emitted by the sun as it passes over a unit horizontal area in time. The incoming solar radiation is modified as it travels through the atmosphere and after it hits the surface. There are three main components of solar radiation which are direct, scattered and reflected solar radiation [7].

2.3 Sun Radiation on Structure

Building materials play a very important role in forming different parts of a building and have different characteristics in exposure to radiant heat. Strength and comfort especially on the building skin are closely related to the building materials used and will affect the flow of heat, convection and radiation [8]. However, solar radiation is also one of the sources of heat gain on external wall. According to Taleb *et al.*, (2020) [9], the reception of solar radiation that attacks the facade of the building is one of the causes of the increase in temperature in the building. Badly constructed buildings will be affected by the reception of solar radiation due to the amount of heat received which will cause defects to the building structure. The creation of solar-friendly buildings needs to be improved in building architecture to increase the building's ability to receive solar radiation and to create a better building layout and architecture. Solar heat radiation will reflect and absorb into the core of the building causing an increase in heat to the building structure and leading to the need to cool the building structure. The findings also revealed that the building skin as well as the direction of the building are greatly affected by solar radiation [10].

2.4 Sun Radiation Causes Paint Coloring Failure

Sun radiation emitted by the sun will degrade the quality of the paint. This process is called photo-degradation. The first phase of this process is photolysis which is where the polymer absorbs ultraviolet radiation and if it is absorbed excessively, it will cause higher energy absorption and cause defects to the paint [11]. According to Alonso-Villar *et al.*, (2021) [12], a major conservation issue for paint deterioration the fact that they consist of using modern paints, which are formulations making them very susceptible to solar radiation and color loss. With this, it is apparent that sun radiation will deteriorate the quality of the paint at the same time, resulting in fading paint on the parts exposed to radiation. The literature review for this study focused on the following key area:

- Sun radiation impact that causes to paint faded on external wall of buildings:
 - The literature review identified whether sun radiation has affected the color fading of exterior wall paint. It will also identify the difference in the causes that cause the paint color to fade, whether it is only influenced by receiving sunlight directly on the surface of the wall or other effects that affect paint coloring causes by sun radiation on the external wall of the building.
- The action need be taken to reduce fading on external wall of building:
 - The literature review will identify that action must be taken to reduce the fading paint on the external wall. This is also a method that should be taken to avoid the occurrence of fading paint on that part.
- Solution to retain the paint coloring:
 - The literature review recommended effective solution strategies for retaining the paint coloring on the external wall. The solution can be using the best quality paint for external walls. This increased the color durability of the paint.

3. Methodology

The researcher conducted face-to-face semi-structured interviews to obtain in-depth information by interviewing 3 contractors, 1 maintenance manager, 1 paint contractor and 1 paint professional.

To achieve the objectives of the study, 6 participants were invited for an interview session. A set of good and structured questions was needed for this research to give an overview of the problem that required deep thinking to identify the objectives and research questions as in Table 1.

Table 1

Research methodology

Research question	Research objective	Research method	Research strategies
What are the solutions that will be taken to overcome the problem of fading paint on building external wall	To recommend the solution of retaining the paint coloring external wall of building	Findings from interview	Interview The Panel of Experts

3.1 Interview

The views presented by the participants were evaluated and informed to measure how these views were based on their understanding. Next, the participant's answer, which is an expert's opinion, will provide support in the construction of the conclusion. Because this study involved interviews as a data collection technique, the researcher does not act as an objective observer and is not involved in any discussion about body language and gestures. The results were only based on the perception of these 6 experts. In addition, interviews were conducted in Malay and English. Table 2 lists the work-related general characteristics of the 6 interviewers.

Table 2

Interviewers' work-related profile

Interview	Position	Work experience (Years)
Respondent A	Paint Contractor	6
Respondent B	Contractor	17
Respondent C	Contractor	22
Respondent D	Contractor	7
Respondent E	Paint Professional	20
Respondent F	Maintenance manager	8

3.2 Findings

By determining the solution of retaining the paint coloring on external wall, there are several solutions suggested by the expert panel. Qualitative data was used for this objective study where interviews were conducted to obtain data on the solution of retaining the paint coloring on the external wall. The implementation of the solution is by implementing the initial process, during and after painting well and the use of quality paint can reduce the paint's ability to fade due to sun radiation. This study has explored some findings to maintain the paint color on the external wall.

4. Results and Discussion

4.1 Recommendations for the Solution of Retaining the Paint Colouring External Wall

4.1.1 Painting process

Based on the results of the interviews, the researcher discovered that the implementation of the painting process from the beginning, during, and after is a very important role in retaining the color of the paint from fading. As mentioned by the paint contractor cleaning the wall of dirt and dust, using a high-quality inner layer and applying many layers of paint. Begin painting the area closest to

the roof and exposed to sun radiation. Complete the process evenly and neatly. The wall painting is a crucial component of the finishing touches because it guarantees the wall's superior appearance; so, the wall painting needs to be smooth [13]. Contractor A believes that keeping the walls dry during the painting process is critical. The researchers found that all the professional panels ensured that the walls were in good condition during the initial painting procedure, with no marks or defects on the external walls. Contractor A mentioned that make sure the wall is in good condition. When painting the weather also needs to be paid attention to make sure that there is no stagnant or leaking water on the wall or the wall. Constant water can corrode the paint faster. Following this, the researcher found that the emphasis during the painting process is very important in the effort to retain the color of the paint from fading for the exterior walls of the building. Primer is a vital step before applying paint. The difference between a pre-primed finish and a surface where the paint has been applied directly is obvious not only in the product but also in the paint's strength and longevity. It's the distinction between a decent and a very good decision [14].

4.1.2 Apply high-quality paint

Based on the results of the interviews, the researcher discovered that to achieve the objectives of the third study. The researcher discovered that the paint contractor mentioned that the quality of the materials used on the building's walls during construction affected the amount of paint durability. According to Pockett, (2010) [15], solar reflection and emissivity are more important than heat conduction via the paint layer. Brighter colors offer the highest surface temperature reduction. Using heat-reflecting paint instead of ordinary paint for colors (visible) can lower surface temperatures. Contractors B, C and Paint professionals believe that good paint quality is the most important factor in retaining the paint coloring by using paints that are resistant to sun radiation reflection, such as Nippon Weatherbond and Jotun Jota Shield, which contain resistant pigments to sun radiation. The use of high-quality paint primer, paint and a good or transparent coating all have an impact on the quality of the paint on the wall. This can boost the paint's endurance and lessen the likelihood of it fading before the intended maturity period. The researchers found that the use of quality paint that can withstand the effects of sunlight can maintain the colour of the paint on the external walls.

4.1.3 Technologies and techniques

The expert panel recommended several technologies to enhance paint color retention based on the questions from the interview. These technologies use reflective paint to limit heat absorption, lowering the temperature of the wall surface, and reducing heat stress on the paint. This will be able to retain the paint coloring on the external wall. As mentioned by paint professionals, increasing nano-pigment technology into the paint material increases the durability and quality of the paint against the reception of sun radiation as well as special pigments to resist and reduce the fading of the paint. This can better preserve the color and longevity of the color paint. However, as stated by contractors B and C, the use of technology and techniques in painting by using the latest technology such as sprayers can also improve the quality of paint adhesion on the wall. According to Megalingam *et al.*, (2020) [16], painting robot that uses a paint sprayer and a ladder lifting mechanism to paint both an interior and external wall of a room. This cascade lift system aids in raising the paint sprayer to the necessary altitude. This is because the fineness of the paint sprayed on the wall makes the paint more even and the applied paintbrush technique plays an important role. The use of a fine paint roller and brush can further improve the smoothness of the paint on the wall and increase the durability of the paint on the exterior wall. The use of sophisticated spraying technology, application

methods, paint types, and paintbrush choices all have a significant impact on retaining paint colors from fading paint on the external wall.

5. Conclusions

Exterior wall paint fades due to sun exposure, which breaks the chemical bonds in the paint and causes color loss and surface degradation over time. Discoloration and gloss changes are the most obvious signs of paint fading, especially on walls exposed to the sun. Maintaining the aesthetic quality and durability of paint on exterior building is a major concern for property owners and maintenance personnel. This research aimed to provide an effective approach to maintaining the color of the paint on the exterior of the building, ensuring the longevity and resistance of the paint to fade caused by external factors. Faded paint not only affects the overall appearance of the structure but can also cause surface damage and increase maintenance costs. Based on this research paper, the researcher issued a solution for retaining the coloring on the external wall of the building from fading. As a result of the findings from the discussion, the researcher obtained three solutions for retaining the wall paint coloring, namely, a thorough and good painting process, the use of high-quality paint, and the use of effective technology and techniques.

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