PEAT

Maintenance Management Study to Building Near the Coastal Area

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Abstract: Buildings in the coastal environment are different from buildings in the inland. The maintenance of buildings in near the coastal areas is different from the maintenance of buildings on land. This is because the humid sea air and high salt levels can erode buildings quickly. Due to higher loads and extreme conditions, these coastal structures are expensive to design, build, maintain, repair, and insure. The objective of this study is to analyse the importance of prevention toward salt attack, to determine the important of maintenance strategy toward building services and to identify the perceived level of resident knowledge toward the importance of building maintenance near the coastal area and resident awareness toward salt attack effect to building near the coastal area. The research method is very important in determining the purpose of the research. After identifying the survey data and purpose, questionnaire was created. A total of 108 respondents from resident of The Light Waterfront have been involved in completing the survey. In this study, all data obtained from the questionnaire were analysed using SPSS, Microsoft Excel and frequency analysis techniques. The frequency analysis techniques were solely used for Section A and Section B in the questionnaire. For Section C, SPSS software and Microsoft Excel were used to obtain the mean value for perceived level of resident awareness toward salt attack effect to building near the coastal area. Based on the result obtained, the objective was found satisfaction as most of the respondent have achieved the level of knowledge toward the importance of building and awareness toward salt attack effect to building near the coastal area.

Keywords: Coastal Construction, Salt Attack, Building Maintenance

1. Introduction

Sea breeze carrying high salt erodes the faded paint and masonry of the building. The ocean atmosphere is humid and contains a high proportion of salt. Due to these combined actions, corrosion of reinforcing bars is promoted mainly by attack by chloride ions and carbonation of concrete. Both

factors can act individually or in combination, both of which significantly impair the durability of the RC structure [1].

Of all the factors affecting corrosion in the reinforcement of RC structures near the sea, the following are the most important: the distance from the coast, the speed and direction of the prevailing winds, the relative humidity, and salt attack. Increases or decreases the presence of wet-drying cycles and the presence of obstacles.

The salinity of the sea splash is closely related to the distance from the shore, and the larger this distance, the lower the salinity. In terms of wind speed and direction Meira et al. (2013) and Fitzgerald (1991) showed a direct relationship between this factor and the salt content of the ocean atmosphere. At velocities above 3 m / s, atmospheric salt content increases and is effective. Amplified. Wind is perpendicular to the coastline. Moisture in coastal areas affects the resistance of concrete and thus has a decisive effect on the rate of corrosion (Meira et al., 2013). We have shown that the wet and dry cycle affects the chloride ion content of the structure itself and poses a danger to the reinforcement. The presence of obstacles also has a significant effect on the salt content of the sea air. This latter effect is even more pronounced in cities where many buildings shield each other [2].

For salt attack, salt in masonry is either present in the masonry at the time of construction or is absorbed from the atmosphere or groundwater throughout the life of the building (Jordan, 2001). Sulfate is commonly found in many types of brick and stone, in Portland cement and in some groundwater sources and is formed in masonry from sulfur dioxide and sulfurous acid in the atmosphere. However, chloride mainly comes from the salty air near the sea, mixing between water and groundwater [3].

1.1 Project Background

Buildings are susceptible to deterioration due to several factors, including climatic conditions, humidity, and structural damage. Common construction errors occur in residential buildings such as The Light Waterfront Penang, Malaysia, salt attack and elevated humidity are considered the most challenging, especially for building conservation. The two problems of increasing humidity due to salt attack are closely related. Moisture from increased humidity can dissolve existing salts in building materials, in addition, groundwater can sometimes contain salts that can seep through the walls of a building. The moisture then evaporates on or just below the surface of the wall, leaving behind salt deposits and rear deposit. These formations gradually contribute to the deterioration of the building, affecting the aesthetic value of the building.

Dissolved salts can easily penetrate buildings with moisture able to transport them further. Therefore, understanding the moisture transport process in porous building materials is essential to prevent salt-induced damage. The effect of salt on the deterioration of buildings near the coastal area, often without transverse seals, has long been known and recognized around the world, although it is not well understood, even if many separate rules regarding salt-induced weathering. On the other hand, not only historical buildings but also modern buildings are subject to the attack of saline solution. It has been found that different contaminants act differently on brick, stone, mortar and even wood, appearing to respond differently to the harmful effects of salt and pollutants. Therefore, it is important to fully understand the problem associated with all porous construction materials and salinity [4].

Apart from that, climate change also greatly impacts on building near the coastal area. Rising temperatures can significantly increase the number of heat waves generated each year. Precipitation fluctuations can cause droughts and floods in different regions. Rising sea levels can flood some coastal areas. These impacts are expected to have multiple environmental and socio-economic impacts, exacerbate existing environmental problems, and increase inequality [5].

In addition, the coastal zone is a very important provider of food and habitat. All these resources share common characteristics: they behave as systems and should be managed as such, they interact

among each other, they have multiple uses and generate many outputs, they supply private and public goods, and they can be supplied by private and public sectors (OECD 1993). These resources are limited and must be conserved. Most countries have conservation programs that address land resources or that address water resources, but too few countries treat them together in a unified framework (Clark 1998). For the sustainable development of coastal zones, coastal resources should not be viewed in isolation from the rest of the ecosystem and from other resource demands. The complexity of coastal zone environments and their management brings together management and research specialists from many disciplines.

1.2 Problem Statement

The maintenance of buildings in water or coastal areas is different from the maintenance of buildings on land. This is because the humid sea air and high salt levels can erode buildings quickly. Due to higher loads and extreme conditions, these coastal structures are expensive to design, build, maintain, repair, and insure. Proper and proper use of building materials, including electrical and mechanical equipment, is important to minimize damage. Today, the problems of global warming, the effects of salt attack and climate change are indirectly since coastal areas are exposed to more extreme conditions. Feedback was sought from local government engineers managing local government buildings in the coastal areas of the Malaysian Peninsular (Roslan et al., 2011) especially in Light Waterfront Penang. Because of that, erosion on buildings may threaten coastal ecosystems or nearby settlement areas. The number of people looking to develop the area or existing tourists is likely to decrease. Furthermore, there is a danger of flooding if the sea level rises.
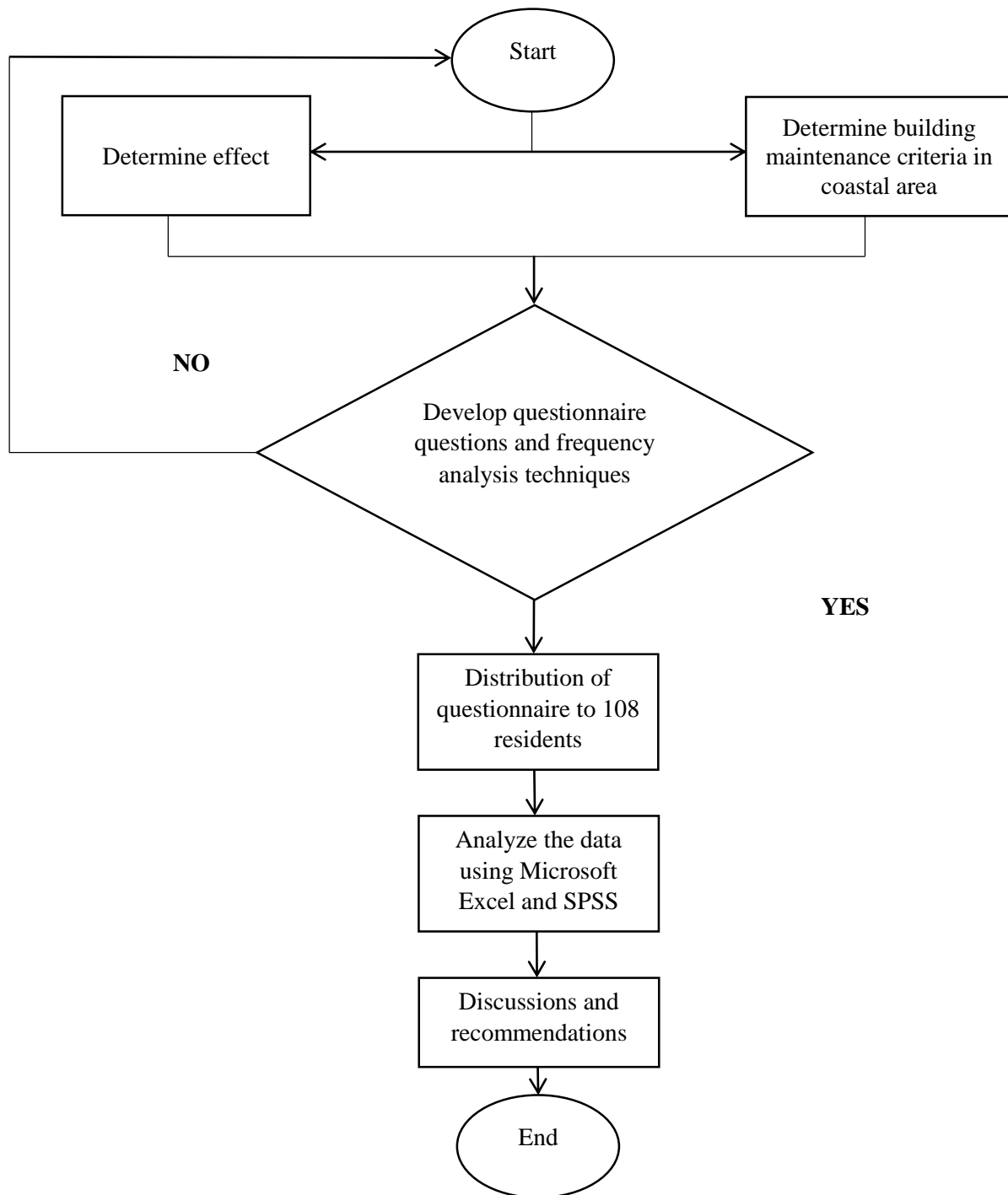
1.3 Aim and Scope

The aim of this study is to analyze the importance of prevention toward salt attack, to determine the importance of maintenance strategy toward building services and to identify the perceived level of resident knowledge toward the importance of building near the coastal area and resident awareness toward salt attack effect to building near the coastal area. The scope of this study is by distributing questionnaires to respondents using a set of questionnaire forms to obtain information. The respondents who take part in answering this survey are residents of The Light Waterfront, Penang. The objectives of this study were as follows.

a) To analyze the importance of prevention toward salt attack.
b) To determine the importance of maintenance strategy toward building services.
c) To identify the perceived level of resident knowledge toward the importance of building near the coastal area and resident awareness toward salt attack effect to building near the coastal area.

2. Methodology

A flow chart is an infographic depicting a system's sequential operations, components, or activity. Quantitative and qualitative methods were utilized in this research to determine the situation's pattern. Figure 1 illustrates a flowchart that might be used to demonstrate the study's research methodologies and procedure more precisely and efficiently.

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                              ┌─────────┐
                              │  Start  │
                              └─────────┘
    ┌──────────────────┐              ┌──────────────────────┐
    │ Determine effect │◄────────────►│ Determine building   │
    │                  │              │ maintenance criteria │
    │                  │              │ in coastal area      │
    └──────────────────┘              └──────────────────────┘

 NO
                    ╱─────────────────────────╲
                   ╱  Develop questionnaire     ╲
                   ╲  questions and frequency   ╱
                    ╲  analysis techniques     ╱
                     ╲───────────────────────╱
                                                    YES
                          ┌──────────────────┐
                          │ Distribution of  │
                          │ questionnaire to │
                          │ 108 residents    │
                          └──────────────────┘
                          ┌──────────────────┐
                          │ Analyze the data │
                          │ using Microsoft  │
                          │ Excel and SPSS   │
                          └──────────────────┘
                          ┌──────────────────┐
                          │ Discussions and  │
                          │ recommendations  │
                          └──────────────────┘
                              ┌─────────┐
                              │   End   │
                              └─────────┘
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Figure 1: Flowchart

2.1 Data Collection

The methodology developed in this study is largely driven by the research objective. Journal, books, articles, thesis and the internet were used as secondary data sources in the study, used to obtain the information needed to design the model and analysis. The survey, as a primary source of data, was used to collect relevant data. The method of collecting data was done by using a questionnaire and an online Google form survey, tailored to the convenience of the respondent.

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In this study, the questionnaire was constructed. It consists of 3 part which are Part A, Part B and Part C. Part A was demographic question that ask for respondents' information. Part B was collected to obtain the level of resident knowledge toward the importance of building maintenance. Meanwhile, Part C was collected to obtain level of resident awareness toward salt attack effect to building near the coastal area. The sample data was done and collected from the survey. In addition, the questions used are Likert-style questions.

2.2 Questionnaire

A Likert scale of 5 is used to assess respondents' knowledge. The questionnaires employ a Likert scale with five (5) categories to assess the residents' level of knowledge toward the importance of building maintenance and awareness toward salt attack effect to building near the coastal area. The frequency analysis method determines the level of respondents' knowledge for each question.

   i.   Section A consist of the background information of the respondents. The questions included in this part are gender, age, job status, race, home ownership and number of households.
  ii.   The question is including the importance of prevention toward salt attack and importance of maintenance strategy toward building services. The Likert scale is used to measure the level of respondents' knowledge toward importance of building maintenance near the coastal area.
 iii.

Table 1: Likert scale is used to measure the level of residents' awareness toward salt attack effect to building near the coastal areas

Scale	1	2	3	4	5
Description	Strongly Disagree	Disagree	Considerable	Agree	Strongly Agree

3. Results and Discussion

Table 2 shows that the result and analysis of the data gathered revealed the following results in term of gender, age, job status, race, home ownership and number of households. A sample from the questionnaire represented the main objective and was distributed to residents of The Light Waterfront, Penang. The distribution show that male represent 43.5% of the respondents, while the ratio of females is 56.5%. The result indicated that most of the respondent (42.6%) are from the age range of 21 to 2 years old. Distribution by race shows that most the respondent are Malay (63.0%). Furthermore, from the job status, it shows that most of the respondent (58.3%) were employed. Distribution of home ownership shown that majority of them is the homeowner (49.1%). Majority of the respondent have number of households 3 to 4 person (40.8%).

Table 2: Demographic respondent

Characteristic	Frequency (n)	Percent
Part A		
Gender		
Male	47	43.5%
Female	61	56.5%
Age		
18 – 20	21	19.4%
21 – 30	46	42.6%

Table 2: Demographic respondent (continue)

31 – 39	31	28.7%
40 and above	10	9.3%
Job Status		
Employed	63	58.3%
Housewife	7	6.5%
Student	34	31.5%
Unemployed	4	3.7%
Race		
Malay	68	63.0%
Indian	20	18.5%
Chinese	20	18.5%
Home Ownership		
Homeowner	53	49.1%
Tenant	24	22.2%
Resident	31	28.7%
Number of households		
1 – 2	32	29.6%
3 – 4	44	40.8%
5 and above	32	29.6%
Total	108	

3.1 Level of resident knowledge toward the importance of building maintenance

Table 3 show respondents' knowledge toward the importance of building maintenance near the coastal area. There are 8 questions that have been used in this questionnaire for section B. All of the values and data obtained were processed by using SPSS software and Microsoft Excel. There are two answer to determine the level of residents' knowledge which are 'Yes' and 'No'. In Q8, the questions are to determine residents' opinion about the cause of climate change on building near the coastal area. There are 4 questions and most of residents agreed that warmer and more acidic ocean, the rise of sea level, increased occurrence and intensity of storm and high tide, and direction of prevailing wind are the main factor of climate change impact on building near the coastal areas.

Table 3: Perceived level of resident knowledge toward the importance of building maintenance

Characteristic	Item	Frequency (n)		Percent	
Part B		Yes	No	Yes	No
Q1	Do you think it is important to raise awareness about building maintenance at coastal area?	98	10	90.7%	9.3%
Q2	Do you think climate change greatly impacts the building maintenance?	97	11	89.8%	10.2%
Q3	Do you know how much climate change has affected the cost of building maintenance near coastal area?	95	13	88.0%	12.0%
Q4	Do you know why adaptation methods for natural environment also can be used as method to protect infrastructure?	94	14	87.0%	13.0%
Q5	Do you know the suitable materials that should be use for building to prevent erosion?	95	13	88.0%	12.0%
Q6	Do you think the threat of salt attack to building maintenance is dangerous?	95	13	88.0%	12.0%
Q7	Do you recognize any type of salt damage impact around your residential area?	94	14	87.0%	13.0%
Q8	In your opinion, what causes the climate change impact on building near the coastal area?				
	1. Warmer and more acidic ocean	96	12	88.89%	11.11%
	2. The rise of sea level	94	14	87.04%	12.96%
	3. Increased occurrence and intensity of storm and high tide	96	12	88.89%	11.11%
	4. Direction of prevailing wind	94	14	87.04%	12.96%

3.2 Level of resident awareness toward salt attack effect to building near the coastal area

Part C was carried out to evaluate the level of resident awareness toward salt attack effect to building near the coastal area. The results were averaged and are mentioned in the following Table 4. The mean of residents' awareness for each question is also calculated. The result illustrates the mean scores of the level of resident awareness ranging from 4.24 to 4.14 on a five-point scale.

Table 4: Perceived level of resident awareness toward salt attack effect to building near the coastal areas

Rank	Question Number	Item	Mean	Standard Deviation	Classification
1	Q3	Need to carry out research to find out suitable materials that should be use.	4.20	0.58	High
2	Q4	Adaptation of natural environment method should be implemented to minimize the threat of salt attack.	4.19	0.60	High
3	Q5	Ventilation system in the building that is maintained can reduce the risk of rising damp.	4.19	0.60	High
4	Q2	Need to carry out a thorough survey to understand the salt attack impact on building.	4.19	0.54	High
5	Q1	Reduction of materials use in building construction that easily erode because of salt attack.	4.18	0.59	High

5. Conclusion

The study on maintenance management to building near the coastal area is based on two objectives which are by identify the perceived level of resident knowledge toward the importance of building maintenance near the coastal area and level of resident awareness toward salt attack effect to building near the coastal area.

Based on the result of the survey that have been conducted, it can be concluded that majority of the respondent from this residential building are female, were age between 21 – 30 years old and Malaysian citizens. A total of 108 respondents were able to cooperate in answering the survey in sharing basic information to achieve demographic trends between gender, age, and race. In addition, among the information used based on the study is personal information such as job status, home ownership and number of households, but all information is guaranteed to be controlled without disclosure to other parties. Nevertheless, this part of the demographic trend is answered perfectly because the data collection can be collected without any problems. This is because the respondent can cooperate in answering the Part A questionnaire based on their personal information.

Overall, the objective can be evaluated in this study. Frequency distribution for respondent have been used for this part to assess the level of resident knowledge toward the importance of building maintenance near the coastal area. Based on the result of the study, the result of the questionnaire on resident knowledge toward the importance of building near the coastal area performed at The Light Waterfront, Penang found satisfaction were based on an analysis of frequency distribution by respondent. Thus, the analysis shows that most of the respondent have achieved the level of knowledge toward the importance of building maintenance near the coastal area. All of the question given were to measure respondents' knowledge and majority of them vote 'yes' which show that they understand the importance to maintain the building.

As a result of the research done to achieve the second objective, which is to identify the level of resident awareness toward salt attack effect to building near the coastal area, based on the questionnaire that have been distributed, there are 5 questions in this part and the data collected were summarize. For this part, the mean data are taken to find out the average of residents respond to the questions. The highest mean score illustrates that most of the respondent are well aware about the salt attack effect toward building near the coastal area.

Acknowledgement

References

[1]   Bisaro, A., & Hinkel, J. (2018). Mobilizing private finance for coastal adaptation: A   literature review. *WIREs Climate Change*, *9*(3). https://doi.org/10.1002/wcc.514

[2]   Adam, J. M., Moreno, J. D., Bonilla, M., & Pellicer, T. M. (2016). Classification of damage to the structures of buildings in towns in coastal areas. Engineering Failure Analysis, 70, 212-221.

https://www.sciencedirect.com/science/article/abs/pii/S1350630716306264

[3]   View of A Review: Durability of Fired Clay Brick Masonry Wall due to Salt Attack. (n.d.). https://penerbit.uthm.edu.my/ojs/index.php/ijie/article/view/93/44

[4]   Delgado, J. M. P. Q. (2016a, December 15). Salt damage can affect the service life of numerous building structures, both historical and contemporary, in a significant way. https://www.hindawi.com/journals/amse/2016/1280894/

[5]   Nunez, C. & National Geographic Staff. (2022, February 16). Sea level rise, explained. Environment. https://www.nationalgeographic.com/environment/article/sea-level-rise-1