

Study on the Deterioration Level of Piping System in old and Heritage Building in Batu Pahat, Johor

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Abstract: The piping systems are an important aspect of the building since water cannot be distributed evenly throughout the structure without them. Because water is a crucial and valuable resource for humans, structural deterioration has created challenges not only to daily life but also to a sustainable society. The purpose of this research is to learn about the maintenance work on the Deterioration Level of Piping System in Old and Heritage Buildings in Batu Pahat, Johor. The valuation used to know the deterioration level are base on JKR Existing Building Inspection Guidelines (JKR 21602 - 0004 – 13). From this research, most of this selected building are being monitored by inexperienced people so most of the problems occur at the building they need to get consult from experts such as engineer from Malaysian Public Works Department. The “Physical State Level Matrix Analysis of Building Components and Priority Level of Maintenance Action” can be used to determine the level of physical condition of a building. Because the maintenance level of this selected building is quite good, the level of deterioration of the piping system in historic and heritage buildings in Batu Pahat, Johor is very low, according to this study. For the future study need to expand the scope of study and Research also needs a contributing approach significantly to explain maintenance concepts related to Production and Operations Management.

Keywords: Piping Systems, Maintenance, Old Building

1. Introduction

Every building has their maintaining process, the maintaining process include plumbing process. Maintaining is important to the building and needs to be done according to the set schedule to ensure the building be well sustained. The real problem in defining maintenance therefore is “a lack of universal agreement as to what represents an acceptable condition ” [1]. All parts of the building need

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to be maintained, one of the parts is plumbing. The plumbing and sanitation materials cover almost 60% of the total cost, so quality and proper selection of materials are very important [2]. All of this part of plumbing needs to be monitoring and well sustained. In the initial period, these services work satisfactory but at a later stage, it needs frequent maintenance to keep the building in serviceable condition [3]. The piping systems usually fail at part of the pipe itself and the joint of the pipe. The possibility of leakage increases with the number of joints [3]. These will cause the flow rate of the water affected. Moreover, the urban water pipe networks are fast growing along with global urbanization

The aim of this study will discover the maintenance work approach for Study on the Deterioration Level of Piping System in Old and Heritage Building in Batu Pahat, Johor. The first objectives of the study are to identify problems and the influencing factors in the plumbing system maintenance for old buildings in Batu Pahat, Johor. Second objective are to determine the general techniques used in maintaining the plumbing system of old buildings in Batu Pahat, Johor. The scope of this study is primarily focusing on a study of the level of piping system deterioration on heritage buildings and maintained systems using by heritage buildings in terms of plumbing and piping. This problem can contribute to many failures to other structures and facilities in the building. There are three building that have being selected in this research which is High School Batu Pahat (HSBP) (Sekolah Menengah Kebangsaan Tinggi Batu Pahat (SMKTBP)), Temenggong Ibrahim Girls School (TIGS) (SMK (P) Temenggong Ibrahim), and the Batu Pahat Municipal Council (Majlis Perbandaran Batu Pahat).

The heritage building has sentimental value that needed to be inherited and sustained. The finding of this study is to know the common problems that happen at the building and how the comprehensive way to overcome the problems that occur in plumbing systems. By these studies, with the identifying of the problems, the building will not suffer the damage that happens much longer or can be prevented because the problem can be predicted. through this analysis, ideally, advantages and a simple explanation will be given to find out how the means or harm that is likely to occur in a building particular to the piping system can occur. Moreover, it can also have the best solution at a reduced cost to deal with plumbing issues and can ensure the building's sustainability.

2. Maintenance of Piping Systems in Old And Heritage Buildings

In our modern world, heritage buildings (HB) inherited from the past are a major element. Heritage includes all buildings, structures, objects, and areas that are important historically, esthetically, and architecturally. [4] Heritage buildings are also identified either in terms of architecture or of history as those that are old and important. Heritage buildings are often defined as existing buildings of important cultural significance to society [5]. Many historic buildings in Malaysia are in bad condition, with symptoms of major structural flaws, posing a threat to their survival because the country's heritage building legislation does not adequately address the issue of maintenance. The management in the conservation of heritage buildings has resulted in poor maintenance management methods, which has led to the buildings' deterioration [6]. The effort necessary to maintain equipment performing at a level equivalent to that of new equipment is known as maintenance. Unplanned downtime due to equipment breakdown is a major concern for businesses, resulting in annual losses of billions of dollars. Maintenance is crucial for increasing production by reducing downtime and enhancing equipment efficiency. Preventive maintenance, or corrective repair following a breakdown, is categorized and executed according to time-based predetermined intervals Preventive maintenance is done to keep equipment from breaking down by repairing or replacing components. Maintenance is performed after a breakdown in the corrective type. Depending on the criticality of the equipment, some maintenance must be performed quickly, while other types of maintenance can be delayed [7].

2.1 Guidelines For The Piping Maintenance

Rusty gutters and swamps, narrow mesh causing overflow during heavy rain, gutters blocked with dirt, rainwater pipes bursting or leaking, bending, and causing poor rainwater drainage are all frequent issues with rainwater drainage systems. Rainwater pipes and gutters that are defective or disrupted cause problems with other aspects of the construction, such as wet and mossy walls and flooring [8]. In malaysia, all these components can be valued through Building Condition Assessment. Building

Condition Assessment also can be seen as a means to increase asset management skills and asset tracking, as well as a way to better manage asset information. Building Condition Assessment is thus one of the activities aimed at reducing financial and capital costs while increasing asset valuation for all stakeholders across the building life cycle. The value of asset awareness and a suitable asset management policy, the latter of which focuses on commercial buildings, is emphasized. Owners will be able to formulate suitable plans and actions for renovation, reconstruction, substantial replacements, refurbishments, and investments if they have a reliable and realistic knowledge of the physical condition of their properties. In Malaysia, BCA from Public Works Department is used to assess the level of damage and function of the building. Both built properties can be reviewed regularly; however, the assessment does not have to be completed all at once; in many cases, the most successful asset monitoring and reporting are accomplished by a scheduled condition assessment method [9].

2.2 Piping Systems

Plumbing is the system of pipes, drain fittings, valves, valve assemblies, and devices installed in a building for the supply of drinking, heating, and washing water, the removal of waterborne waste, and the technical occupation of operating in such systems with pipes, tubes and plumbing fixtures [3]. This system not only at the wall but also can be under the ground or above the building. Mechanical seals are also needed in the piping systems to provide a flushing fluid across seal faces, to create flow paths for different seal configurations, and to set component positions. Toilets, toilets, and washing machines are the main demand for indoor water in the residential sector. [10]. So, piping or plumbing systems are very important to the building and need to be well maintained according to the schedule so that the building can be well operated.

Piping systems have many factors that can cause the piping system to fail or damage. Sometimes the problems can happen on the water supply pipe. There are many types of material of the pipe usually use in the building such as steel, cast iron, and plastic. the most common plumbing problems with water supply pipes are leakages, low pressure, breakage, and corrosion of pipes. The combination of piping and fittings with a fair service factor for system reliability is a good design practice. A pipe with a pressure rating of 200 psi, for example, should not be used in a 175-psi operating pressure system. The pressure of the unit must include both static and anticipated surge pressure [11]. Two topics revolve around these issues: material used for pipes and how the worker installs pipes. All issues related to piping stem from these two variables [3].

Major issues involve leaking pipes. It not only wastes water but also impacts the occupants' everyday routine. Constant leaks in walls through pipes contribute to water seepage, which can damage the building's structural components. If the issue is left undetected, leaks can lead to severe consequences. For instance, if left undetected, continuous dripping of a tap can damage the external surface of the wall, plaster, ceilings and destroy paint finishes. It can prove to be costly to repair such damage. Due to external environmental conditions, damage to pipes can occur, which may lead to frosting, thawing, bursting, and cracking, or there may be issues such as mishandling of on-site pipes, poor installation, fittings, and joints that do not determine the correct [3]. In the article of [12]. In that the plumbing facilities become difficult to access, causing a delay in carrying out the necessary maintenance operation. In essence, this would lead to delays in the scope of repairs for the plumbing plant. To identify the cause, it can require some thorough analytical review of the entire installation if systems have repeated failures. The presence of pressure surges, or water hammers, may also indicate the closeness of the failures to each other [11]. The delay would result in a rise in the maintenance cost allocated for the maintenance of the plumbing.

3. Materials and Methods

The main data of this study were obtained from two methods. The methods used are site visits and interviews of civil engineers as well as facility management. Each of these methods is different based on the information to be obtained. The site visit was around Patu Pahat. During site visits, the buildings heritage building at the area of Batu Pahat that still on the use of running and using piping systems were identified. Among the buildings that will be studied are the High School Batu Pahat (HSBP) (Sekolah

Menengah Kebangsaan Tinggi Batu Pahat (SMKTBP)), Temenggong Ibrahim Girls School (TIGS) (SMK (P) Temenggong Ibrahim), and the Batu Pahat Municipal Council (Majlis Perbandaran Batu Pahat). During site visits, observations on piping systems will be made. Through interviews with civil engineering, the technician that responsible for maintenance of the building, the problem associated with piping systems, and maintenance method that applied to the problems also being obtained.

To accomplish the objectives of the report, the interviews conducted were split into three sections. Section A is the data of respondents, the Batu Pahat High School (HSBP), and the Municipal Council of Batu Pahat. While Part B is divided into questions about the problem of piping systems and the maintenance aspect of the building, namely to answer the first objective of the study and Part C on the maintenance model for building to answer the second objective of the study.

3.1 Data Analysis

Qualitative methods are generally analyzing data obtained from interviews as well as observations. Through the interview method, the data that can be obtained is based on information from the engineering of the building or the technician for the maintenance of the building. Each data collected will be reviewed, classified, and discussed. It focuses on the important information needed to meet the objectives and adds information related to the study conducted. Among the data analyzed are data on identifying the problems and the influencing factors in the plumbing system maintenance and the general techniques used in maintaining the plumbing system for the building. All of the data that get from the site visit has been graded base on the Level of Physical Condition of Building Components (Table 1), Priority Level of Maintenance Action (Table 2), and Physical State Level Matrix Analysis of Building Components and Priority Level of Maintenance Action (Table 3). After identifying the level of component, the Building Rating Classification (Table 4) can be determined. All of this valuation refers to JKR Existing Building Inspection Guidelines (JKR 21602 - 0004 – 13).

Table 1: Level of Physical Condition of Building Components

Grade	Inspection Scale	Acronym	Description
1	Very Good	SB	<ul style="list-style-type: none"> • No Defects; • Very good condition; and • Can work well
2	Good	B	<ul style="list-style-type: none"> • There is a defect or minor damage; • Good condition; and • Can work well
3	Moderate	S	<ul style="list-style-type: none"> • There is a defect or major damage; • Moderate conditions; and • Can still work but needs to be monitored
4	Critical	K	<ul style="list-style-type: none"> • No, / there is a defect or major/minor damage; • Critical conditions; and • Unable to function according to the level of service agreed
5	Very Critical	SK	<ul style="list-style-type: none"> • Very critical condition; • Not functioning; and • Risky as possible cause an accident and or injury

Table 2: Priority Level of Maintenance Action

Priority	Scale Assessment	Acronym	Description
Normal	1	N	<ul style="list-style-type: none"> No signs of defects or damage Components/elements are maintained well, no need for repairs.
Routine	2	R	<ul style="list-style-type: none"> Minor damage/defects Needs to be monitored, repaired, and replaced to avoid defects/damage which is more serious.
Repairs	3	PB	<ul style="list-style-type: none"> Major damage / defects, Needs major repairs, needs to be repaired/replaced.
Recovery	4	PM	<ul style="list-style-type: none"> Serious damage / defects, the need for repairs urgent, urgent, and immediate.
Replacement	5	PG	<ul style="list-style-type: none"> Very serious damage/defect, need for replacement / urgent repairs, urgently needed and immediately, Requires detailed inspection expert.

Table 3: Level Matrix Analysis of Building Components

Scale		Priority Level of Maintenance Action				
		5	4	3	2	1
Level of Physical Condition Building Component	5	25	20	15	10	5
	4	20	16	12	8	4
	3	15	12	9	6	3
	2	10	8	6	4	2
	1	5	4	3	2	1

Table 4 : Building Rating Classification

Rating	Conditions	Action Matrix	Score
A	Very Good	Scheduled maintenance	1 to 5
B	Good	Condition based Maintenance (Condition Based)	6 to 10
C	Moderate	Repairs	11 to 15
D	Critical	Recovery	16 to 20
E	Very Critical	Replacement	21 to 25

4. Results and Discussion

Based on the the site visit and interview that already been done at the selected building which is High School Batu Pahat (HSBP) (Sekolah Menengah Kebangsaan Tinggi Batu Pahat (SMKTBP)), Temenggong Ibrahim Girls School (TIGS) (SMK (P) Temenggong Ibrahim), and the Batu Pahat Municipal Council (Majlis Perbandaran Batu Pahat). The instructor and lab assistant for these selected schools, Encik Muhamad Asri for High School Batu Pahat and Temenggong Ibrahim Girls School Puan

Hj Hamimah, are in charge of plumbing maintenance. Encik Mohd Ridzuan, the assistant engineer for Batu Pahat Municipal Council, is in charge of the building's plumbing maintenance.

Referring to the Standard guideline for Building Condition Assessment (BCA) for Existing Building from the Public Works Department (JKR), the condition of the pipe for this selected building is not at high risk of damage. The material of the pipe at this selected building has already been replaced by new pipes such as Polyethylene (PE) and Polyethylene (PE). Some of the plumbing systems are still using the old systems and many of them are already being replaced.

3.1 Level of Deteriorate and Building Rating Classification

The site visit for this research will cover up only the building that has the heritage criteria or already has been certificated as a heritage building by Jabatan Warisan Negara. The component that has the most damage or defect will be chosen to be rate base on the building condition assessment by Public Works Department (JKR).

Building rating classification is for knowing the rate of the building component. From the rate of the component, the overall rating of the building can be determined. Inspection and rating of the building's state can also aid with the historical building's conservation component (Table 5, 6 and 7)

Table 5: Schedule of Building Condition (CSPI Matrix) (TIGS)

Subsystem	Component	Condition Assessment	Priority Assessment	Matrix Analysis
Sanitary fittings	Toilet seat / squat	2	1	2
	Sink	1	1	1
	Hand washing place	1	1	1
Internal distribution pipes	Pipe	1	1	1
	Stop cock	2	2	4
	Faucet	2	2	4
Service pipeline	Pipe	4	4	16
	Joint	1	1	1
	Stop cock	1	1	1
Sanitary waste	Water storage tank	1	1	1
	Pipe	2	1	2
	Bracket	1	1	1
	Traps	2	1	2
Total Mark			37	
Number of Defect			13	
Total Score			2.814	
Overall Building Rating			Very Good	

Table 6: Schedule of Building Condition (CSPI Matrix) (HSBP)

Subsystem	Component	Condition Assessment	Priority Assessment	Matrix Analysis
Sanitary fittings	Toilet seat / squat	1	1	1
	Sink	3	2	6
	Hand washing place	1	2	2
Internal distribution pipes	Pipe	1	1	1
	Internal water tank	1	1	1

	Stop cock	2	2	2
	Faucet	2	2	4
Service pipeline	Pipe	1	1	1
	Bracket	1	1	1
	Joint	1	1	1
	Stop cock	1	1	1
	Water storage tank	1	1	1
Sanitary waste	Pipe	3	2	6
	Bracket	2	2	4
	Traps	4	4	16
Total Mark			48	
Number of Defect			15	
Total Score			3.2	
Overall Building Rating		Very Good		

Table 7: Schedule of Building Condition (CSPI Matrix) (BPMC)

Subsystem	Component	Condition Assessment	Priority Assessment	Matrix Analysis
Sanitary fittings	Toilet seat / squat	2	1	2
	Sink	1	1	1
	Hand washing place	1	1	1
Internal distribution pipes	Pipe	2	1	2
	Stop cock	1	1	1
	Faucet	2	1	2
Service pipeline	Pipe	1	1	1
	Bracket	2	1	2
	Joint	1	1	1
	Stop cock	1	1	1
	Water storage tank	1	1	1
Sanitary waste	Pipe	1	1	1
	Bracket	1	1	1
	Traps	1	1	1
Total Mark			18	
Number of Defect			14	
Total Score			1.285	
Overall Building Rating		Very Good		

3.2 The Factors of Effectiveness Management

Base on the interview and site visit at these selected buildings, several factors affect the maintenance process such as the budget for maintenance, procedure, lack of experience, and vandalism. For the maintenance, all maintenance work has a process or procedure that needs to be done before it can be carried out. This procedure can become a factor of failure or delay in performing maintenance work because the process takes too much time to be approved. It can make the failure or the damage of the component worse because it was left for too long. Next, If the budget of the maintenance work unreachable, the maintenance cannot proceed and the damage cannot be fixed. The school needs to find another source of fund for the maintenance maintaining work due to lack of funds. School will collect the fund from the idea of Parent-Teacher Associations to top up the maintenance budget. Batu Pahat Municipal Council has more experience in maintenance than the school. The school only uses

unplanned maintenance with the work only done upon receipt of complaints from users. This is because the school maintenance party consists of the teachers themselves. They have expertise such as engineer and assistant engineer. The problem of clogged toilets can be caused by damage to the faucet or leaky pipes. This contributes to the increased maintenance costs of a component and needs to be curbed. It is important to regularly monitor the water pressure in the piping area. All of these factors can make the maintenance process to be a delay or the maintenance work is not solving the problem that occurs at the component of the building so all of these need to be addressed so that maintenance work on the building can be carried out smoothly

5. Conclusion

Last, maintenance studies are necessary to guarantee that the techniques of maintenance used are effective and appropriate for the application. This research might also reveal the state of the pipe systems for the heritage building in Batu Pahat. The amount of damage for heritage buildings based on the selected building is extremely low, according to the conclusions of the study, because the building rating classification shows that the rating of the building is A and the condition is quite good. Only planned maintenance is required for the action matrix for these buildings. The method of maintenance should be improved in terms of the duration of maintenance action taken and also the maintenance management needs to be improved.

Several suggestions can be made and recommended to maintenance management of these selected buildings in ensuring that the maintenance method of piping and plumbing maintenance systems can be applied without any other problems. Among the suggestions that can be proposed are:

- i. The efficiency of the contractor is important in ensuring that maintenance methods are applied correctly. Every maintenance information must be emphasized to ensure that the method used is effective and applicable. The maintenance contractor needs to make sure any problems that occur are resolved before the complaint is closed. The maintenance management must monitor the maintenance work performed by the contractor
- ii. Periodical maintenance should be done every year. This is to ensure that is no problem occurs. In fact, every problem can be repaired and maintained before the problem occurs. This periodic maintenance system is also able to make piping systems at the buildings free of damage (zero defect).
- iii. The result shows that building that has the expertise to manage the maintenance at the building have a higher grade for building rating classification compare to others building. This is because, with the expertise, solving problems that happen at the building will be more efficient with a guide from the expertise
- iv. The period for complaints to be processed is two (2) days to fourteen (14) days based on the applicable complaint application. For major problems, the maintenance time that should be taken is one (1) day. Meanwhile, for minor problems, maintenance work should be done within five (5) days. This is to prevent the problem from getting worse and disrupting the comfort and activities of users

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