
FAÇADE MAINTAINABILITY FOR MOSQUES: A REVIEW FOR MAINTENANCE CONSIDERATION

Muhammad Amirul Aizat Abdullah¹, Nor Rima Muhamad Ariff², Norsalisma Ismail³ and Julaida Kaliwon⁴

^{1,2,3,4}*Centre of Studies for Postgraduate Studies, Faculty of Architecture, Planning and Surveying
Universiti Teknologi MARA Shah Alam
40450 Shah Alam, Selangor, Malaysia
Email: aizatabd@gmail.com*

Abstract

In every type of building, maintenance always play a main role to make sure the building is in good condition and maintain its function for a long term. Unfortunately, the lack of concern towards building maintenance, especially the façade of building lead to difficult and costly maintenance. A majority of maintenance operation for building facade suffers from the lack of maintenance planning, access and routine. Façade is the key element of a building and it influences the comfort, safety and aesthetics of every building. Studies on mosque buildings in Malaysia have highlighted that lack of facade maintainability has caused a large financial impact on the building total maintenance cost. This study aims to investigate the effect of facade maintainability factors on mosque building maintenance operation that will provide information and recommendations that could be taken during design phase. At the same time, theoretical framework for a proposed study is presented in this paper. The establishment of maintainability factors which influence maintenance of building façade helps to intensify knowledge and understanding the importance of maintenance for every building design.

Keywords: *Facade Maintainability, Maintenance Consideration, Mosque*

1.0 INTRODUCTION

Malaysia stands among the countries with rich architectural diversity and historic buildings which forms their national identity. Concurrently, due to their multiracial and vast cultural diversity, this country is born with history and cultural effects (Johar *et al.*, 2012). For a country that has a majority of Muslim population, mosque is a common building found in most urban and rural areas in the country (Ahmad, 1999; Utaberta *et al.*, 2012). According to Azhar (2008) and Adil *et al.* (2013), a mosque is utilised as one of the greatest place for worship, holding various religious ceremonies and rituals but nowadays certain people have underestimated the role of a mosque as a place to only perform prayer.

As a locality landmark and one of the public attractions, a mosque should create and provide a good impression because a well-maintained

mosque will attract Muslims and people from different race to come (Ibrahim *et al.*, 2009). Mustafa *et al.* (2011) stated mosques as with the other older buildings, are also affected by defects and deteriorations due to wear and tear process which can be seriously found in a building with lack of maintenance carried in such a way. Lack of maintenance in a building might result in deterioration that leads the building to the point of having to be demolished or collapsed (Ishak, Chohan & Ramly, 2007). Lack of understanding on the importance of maintaining a building has led to an attitude that maintenance of civil work is less important as compared to maintenance of services in the buildings (De Silva *et al.*, 2012).

Issue in building maintenance is universal and consideration for maintenance, especially in design phase, is of great importance because failure in design would lead to deficiencies, at the same time financial burden to the building in post

construction stage (Arditi & Nawakorawit, 1999; Razak & Jaafar, 2012; Chandler & Lewis, 2011). Errors in design not only affect the comforts of building users, but would also harm them (Rahman & Salim, 2013).

Currently, building designs are becoming more complex and the need for effective maintenance is very crucial for façades of buildings (Jordan, 2006). Facades must be periodically maintained with manual procedures (Moon *et al.*, 2011) since it is the most important exterior envelope element of a building that is directly related to the worsening effects from weathering (Kanniyapan *et al.*, 2015).

Nowadays, in many developing countries building designers has given little attention to maintainability which leads to financial losses (De Silva & Ranasinghe, 2010a; Ikpo, 2009; De Silva *et al.*, 2004) and also research in this area is very limited (Das & Chew, 2011). As a result, maintenance consideration is neglected in building design and has led to serious maintainability problems (Sulaiman *et al.*, 2013).

The purpose of this study is to investigate the effect of facade maintainability factors to mosque building maintenance operation which focuses on performance and management of different building maintenance aspects. This paper begins with reviewing issues and criteria for façade maintainability. This is followed by reviews on the impact of façade defects, maintenance and access to façade maintainability. Finally, the paper concludes with discussion and theoretical framework about knowledge on maintainability factors to reduce the maintenance cost for a building and create a building design for easy maintenance work in terms of time.

2.0 FAÇADE MAINTAINABILITY

Maintainability can be defined as the ability to keep on maintaining a building, within a period of time, and enhancing building performance throughout its lifespan within the minimum risk and life cycle cost (Sulaiman *et al.*, 2013). In addition, maintainability may also be expressed as the probability an item will be restored or retained within a given period of time in a specific condition (BS3811:1993). Meanwhile, Chew & De Silva (2003) defined maintainability as

achieving the optimum performance of a building through the building lifespan within a minimum life cycle cost.

Ease of maintenance projects is a concept of maintainability by bringing experience and knowledge at the same time with the possible maintenance concern and issues during the planning stage of a project (Saghatforoush *et al.*, 2012). Due to increasing life cycle cost of building, maintainability needs to be considered during design phase (Ganisen *et al.*, 2015; De Silva *et al.*, 2012), to choose material and design of a building that can minimise risk and failures (Chew *et al.*, 2006). According to Ikpo (2009), maintainability of a building is one of the important factors in the building and estimation components of the building for a long term.

Facade maintainability is an important factor which need to be considered because facade is constantly exposed to weather and experience a defect which will obviously implicate the need for repair work (Erdly & Schwartz, 2004; Beasley, 2012; Chew *et al.*, 2006). A maintainable facade is defined as a facade that is easy to maintain and requires minimal cleaning, repair and replacement (Erdly & Schwartz, 2004; Chew, De Silva & Tan, 2003). According to Flores-Colen and De Brito (2010), façade should fulfil users' requirements which are economical and sustainable to minimise budget and decline for building life cycle performance.

However, Jordan (2010) mentioned that due to current legislation, designers must consider long-term maintenance of a building to provide the most economical and practical maintenance strategy. Building maintainability largely influence durability of building facilities. It is considered highly critical in recent days (Kanniyapan *et al.*, 2015) and has received deficient consideration during design stage (Sulaiman *et al.*, 2013). Maintainability must be properly built in at each facade system phase life cycle (Ping, 2004). Inspired from the literature review, this paper review three areas of concern related to maintainability of facade, which are (1) façade defect, (2) façade maintenance and (3) façade access.

2.1 Façade Defect

Building defect is a symptom in a building that can reduce its value and quality which may lead to a dangerous situation with building users (Rahman *et al.*, 2013). Sui Pheng and Wee (2001) and Mills *et al.* (2009) stated, building defect is when there is a failure or deficiency for the building performance and function of the structure, services, fabric and other facilities once the building is operational. Similarly, Minato (2003) and Ahzahar *et al.* (2011) defined defects as an occurrence of unexpected events on the site, such as failure of a building structure and lack of something that is necessary for every building to prevent from any deficiency.

A defect will basically occur when a component is no longer functioning (Georgiou, 2010) and may arise from various factors, such as poor workmanship, design fault, wrong selection of material which cause delays (Rahman & Salim, 2013; Ahzahar *et al.*, 2011; Sui Pheng & Wee, 2001). Construction defects failures are always the key concern and common phenomena in the construction industry (Chong & Low, 2005; Ahzahar *et al.*, 2011).

The main function of a building is to protect the occupants and contents from weather and to provide basic needs which will achieve these functions (Ahzahar *et al.*, 2011). Building façade largely influence the impression of a building, but today many façades of a building do not meet basic requirement of a building and often constitute a large percentage of its total life cycle cost (Ping, 2004).

2.1.1 Causes of Building Defect

A defective design is defined as a product design that is produced without confirmation of acceptable quality level which is required by regulations to bring an adverse impact on project performances and will cause many construction failures (Minato, 2003). Faulty design causes latent defect and it is one of the main maintenance problems in a building (Wong & Chan, 2014). Hence, there is no compensation for any damages on a building that are caused by faulty design because it places a heavy burden on the building life span (Ishak *et al.*, 2007). Defects arising from building design error can always be seen through

building performance which leads to a chain effect that will contribute to high maintenance cost (Arditi & Nawakorawit, 1999; Das & Chew, 2011; Ilozor *et al.*, 2004).

Based on Figure 1, Chew *et al.* (2003) listed three major causes of defect arising from the building. They highlighted that the omissions of design largely influence the causes of defect to arise in building with 68% as compared to poor workmanship (30%) and poor maintenance method and strategies (2%).

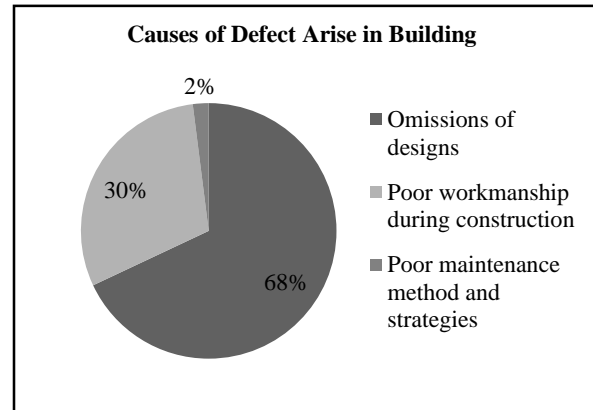


Figure 1: Causes of defect arise in building
Source: (Chew *et al.*, 2003)

Their study shows that the design of building plays a major role and is important to be considered in early design stage to minimise building defects. Faulty or defective building design will affect maintenance problem and will result in building defects.

2.1.2 Causes of Façade Defect

This study draws on research conducted by Kanniyapan *et al.* (2015), with past researchers who carried out research with 59 building managers. It was revealed by percentage that facade defects were caused by faulty design, wrong material selection, construction erroneous and environment due to maintenance practices. Figure 2 shows the defect percentage that affects building façade. From the percentage, design and material contributed more to the facades deficiencies.

Regarding fault in design, lack of construction knowledge and designers experience are two problems currently faced by designers

that affect defect maintenance cost (Chong & Low, 2005; Andi & Minato, 2004) and these problems will lead to serious and unexpected future construction problems (Ahzahr *et al.*, 2011). Knowledge in building physical properties is one of the main considerations during early construction phase (Ishak *et al.*, 2007) and it is important to understand defects factors and mechanism on how the design defects occur in order to effectively reduce them (Minato, 2003).

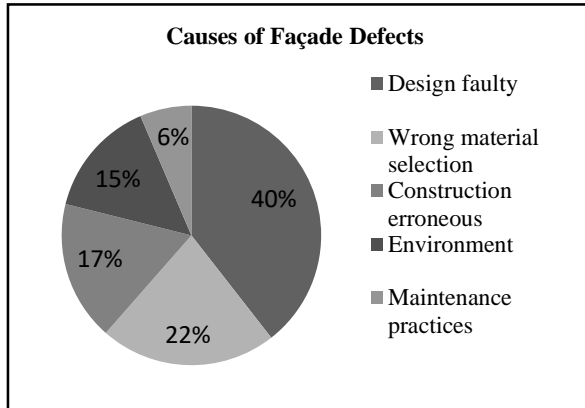


Figure 2: Causes of façade defects
Source: (Kanniyapan *et al.*, 2015)

Aside from knowledge on building physical properties, selection of facade materials is essential to achieve design maintainability (Kanniyapan *et al.*, 2015). Inappropriate facade materials selection can lead to facade defects that will affect maintainability of building (Ishak *et al.*, 2007) (Chong *et al.*, 2005). Hence, maintenance consideration for facade designs is important so that cleaning and maintenance work cost may be minimised (Chew & Tan, 2003). Beasley (2012) mentioned façade does not provide any symptoms that represent the need for major replacement or repair. Concealed facade failures are of more concern than those that are readily visually detectable.

2.2 Façade Maintenance

Maintenance is an activity to conserve, preserve, manage and regulate buildings, facilities, equipment, services and its surrounding buildings to meet current standards and legal requirements (Nawi *et al.*, 2014; De Silva, 2011). According to British Standard (3811:1984), building

maintenance is defined as a combination of any actions carried out to retain an item in or restore it to an acceptable condition. Maintenance is one of the important factors due to rapid development for building lifespan in today's construction industry and also responsible for minimising and removing all undesirable and unexpected influences in buildings, such as building defects (Chew *et al.*, 2004a; Sivanathan *et al.*, 2012; Arditi & Nawakorawit, 1999). Hence, considering maintenance at the design stage has a great impact for future performance and building quality (Arditi & Nawakorawit, 1999).

Facade is the main factor in every building because it defines building appearance (Willmott & Harris, 2001) and need to function and have proper maintenance work (Chew *et al.*, 2004b). Unfortunately, nowadays many facades do not meet the basic requirement (Chew *et al.*, 2004b) and designers only look at the uniqueness of the building façade design rather than the building life cycle approach (Alshawi & Underwood, 1999). Building façade is a complex system and maintainable façade should be designed to effect maximum downtime and availability to maintain building performance for a long time (Chew *et al.*, 2005). Building façade is the first obstacle encountered by external defects agents which result in greater loss in building façade performance than other building component (De Souza *et al.*, 2016).

According to El-Haram and Horner (2003), major construction project was planned and designed with a little consideration on maintenance cost which will affect the future maintenance operating cost that might be higher from the initial capital cost. Hence, Ganisen *et al.* (2015) mentioned that many problems faced in building during the maintenance phase are the result of inconsideration on maintainability during the building design. Lateef (2010) asserted that maintenance cannot be based on the results of physical inspections only but maintenance work also need to be correctly managed. With proper building design, good workmanship and proper maintenance strategies, defect occurrence can be minimised (Chew *et al.*, 2003) and may delay the building defects process (Sui Pheng *et al.*, 2001).

Building maintenance is very crucial to keep building, infrastructure and equipment in the best

condition (Wing *et al.*, 2016) because as stated by Au-Yong, Ali and Ahmad (2014), maintenance costs of a building are continuously increasing because of poor maintenance. There are always delays in maintenance work actions because of lack funds from the building owner, which will then lead to increasing number of building structures deterioration (Paulo *et al.*, 2014). For a great importance to function quality and future building lifecycle cost, the issues of building performance and maintenance need to be considered at the design stage (Chew *et al.*, 2005; Ganisen *et al.*, 2015) and facade system should yield minimum defects to achieve building maintainability (Chew *et al.*, 2005).

2.3 Façade Access

Several decades ago, facade access was not a major consideration in most building design, which is important for maintenance work (Lewis *et al.*, 2012). Chew *et al.* (2003) stated that facade is a major component for every building because a defective facade system would have a large financial impact on building maintenance cost. A facade that is easy to maintain and requires minimal maintenance work is defined as a maintainable facade. According to Moon *et al.* (2011), facade surfaces are often difficult to access by people. Hence, ignoring access for building maintenance will increase building cost and effort because buildings are designed so that maintenance work can be done properly and any place in the building is accessible to maintenance staff and equipment (Al-Hammad *et al.*, 1997).

The overall performance of building facade depends on facade performance and component (Flores *et al.*, 2010). According to Sivanathan *et al.* (2012), common problem in most of the building, such as lack of consideration to accessibility need, choice of material and poor communication among parties, are usually caused by early construction design because of its inadequate maintenance input during design which can lead to a lot of problem in building maintenance, especially during post occupancy. According to De Silva *et al.* (2012), the lack of attention to maintainability during design and construction phases has led to difficult and costly maintenance. The designer's lack of consideration for building facade access

requirement can cause maintenance problem and the need to consider maintenance access in a building to ensure an effective maintenance is carried out for a building lifetime of a (Ishak *et al.*, 2007). Faults in building design place a heavy burden on the building for rest of its life and there is no compensation for it (Chew *et al.*, 2003).

2.3.1 Implication of Design Fault to Façade Access for Maintenance

The implication of design fault on maintenance in buildings has resulted from the consequence of poor design for access of maintenance will cause a delay in the repair process that escalates the cost and increases the probability of substandard remedial actions (Ishak *et al.*, 2007). According to De Silva (2011), efficient maintenance process can be achieved with emphasising easy access for various building elements and components which are needed to consider the access ways, access methods whether it is permanent or temporary and also a number of different access systems for the whole building.

Unfortunately, most building designers do not really have a long-term interest for a building in normal contact system and not affected by the maintainability problems that follow from their limited involvement for the construction process (De Silva & Ranasinghe, 2010b; Chong & Low, 2006). From past studies, it can be concluded that during the design stage, there was lack of attention given to the evaluation and selection of facade system when designing a building (Kanniyapan *et al.*, 2015). Facade system failure and shorter economic life in the building need to be fully understood and appreciate the cost and benefit compromised for the building. Facade is considered a failure if it does not perform the economic life for the building satisfactorily (Beasley, 2012) and will result in building defects that were too late to verify and were latent and occurred after occupancy (Chong *et al.*, 2006).

In addition, maintenance and facility manager involvement during construction and design process in local industry is almost negligible (De Silva *et al.*, 2010). Arditi & Nawakorawit (1999) stated that building design inefficiencies was reported by property manager as the most important problem that they faced in maintenance work and building operation.

Hence, Chong *et al.* (2005) stated that specified information from maintenance people is important for the designer so that efficient and economical maintenance and construction operations can be achieved. At the same time, any errors in building design could be prevented in the future.

3.0 METHODOLOGY

This paper employed qualitative method for primary data. This paper is specifically assigned to review and search the literature on maintenance consideration of façade maintainability. According to Kanniyapan *et al.* (2015) and Sandelowski (1995), content analysis is known as analyzing documents method which allows researcher to enhance understanding of data and issues that will classify content into categories. The literature sample comprised from reviewed papers, books, journals and proceedings from conferences in the boxes covering nineteen-year-period, from 1997 to 2016. Literature sample was collected by conducting literature search to relevant keywords, such as “façade maintainability”, “building maintainability”, “maintenance consideration”, “mosque maintenance” and “building design”. Journal articles were retrieved from reliable sources, such as UiTM Library, Science Direct, SCOPUS, Emerald Insight, ASCE Library and free access journal platforms. A total of 40 journal articles related to maintenance for facade maintainability were selected and reviewed (Figure 3).

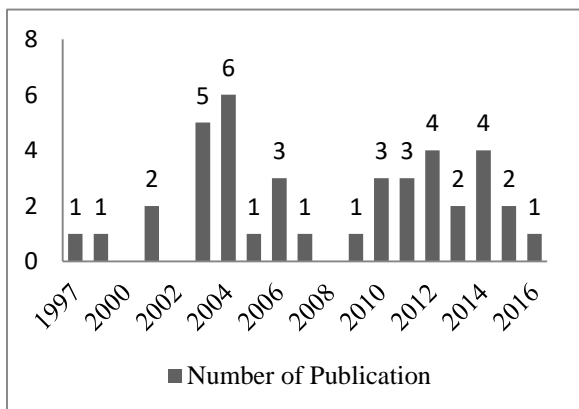


Figure 3: Publication from year 1997-2016.

4.0 RESULTS AND DISCUSSION

The objectives of a building maintainability are to minimize life cycle cost and to increase building performance within minimum risk. Each building requires maintenance to maintain its performance and lifespan. Thus, a consistent and well-planned maintenance and cleaning regime is needed to minimize unexpected situation to the building, especially façade which is exposed to adverse weather and to ensure the facade remain aesthetic.

Figure 4 shows four factors that influence façade maintainability that was analyzed from each journal. They are design, maintenance, construction and environment. Any mistake or lack of consideration on these factors will lead to huge impact on future building maintenance. From all of these factors, a building design plays a main role in which it greatly influences facade maintainability. Any faulty building design will totally affect future maintenance and construction. Design review is very important for the designer because it is part of early design process which will assist in preventing the building from defective design.

If the designers do not properly consider and overlook some details or construction and design, it will lead to a defective design with lack of maintenance consideration. According to Basbagill *et al.* (2013), decisions made during early design stage for a building is critical to determine building impact but designers often delay on decisions to later stages of the design process. This leads to a defective design. Lack of maintenance or inadequate maintenance in the building not only causes dangerous situations, but also health problems with occupants of the building. Ganisen *et al.* (2015) mentioned, building maintainability is an important factor that needs consideration for every building design to improve and maintain building performance including quality, health and safety and building management to reduce maintenance cost and provide a comfortable condition to occupants.

In order to have proper maintenance work, every part of the building must be accessed for maintenance and cleaning work. With the complexity of building facade design, the need for maintenance access will increase. De Silva *et al.* (2012) stated that improving maintainability at

design stage of each building can make the maintenance work smoother. Replacement of facade material will also be difficult if the building is too high to access as maintenance equipment will be difficult to reach the defect area and thus lead to delay in maintenance work. According to Ashworth (1996), delay of maintenance work will affect building performance for a long time and lead to serious building defect and damage. The building will not be fully maintained or effectively operated if the

equipment cannot access. It is clear that maintenance consideration, especially for facade access, is important to be considered at early design stage as it will affect performance expression and building architecture. Even minor damage will generate significant problems to the building. By considering maintenance at early design phase, it will give the opportunity in terms of maintenance cost and building lifespan for a long term.

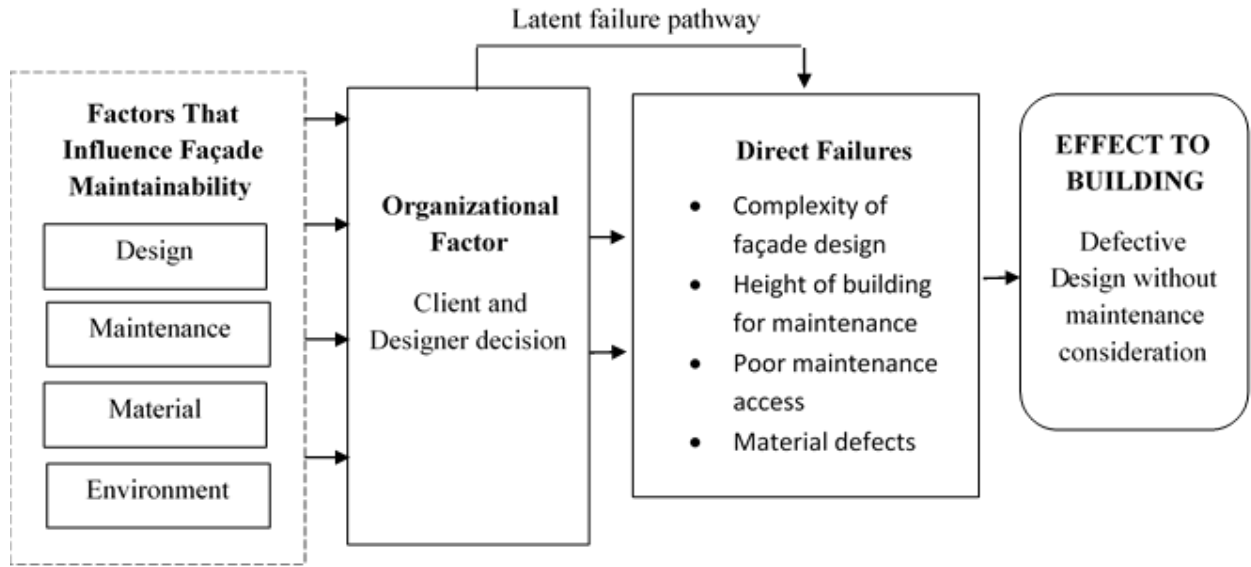


Figure 4: Conceptual framework of this research

5.0 CONCLUSION

In summary, this paper highlighted three areas of concern relating to facade maintainability, which are facade defect, maintenance and access. These factors are important and need to be considered at an early design phase to achieve building maintainability especially for building facade. Hence, cost of maintenance can be minimized and at the same time will maintain building performance and lifespan.

ACKNOWLEDGEMENT

This research was funded by Institute of Research Management and Innovation (IRMI) (600-IRMI/DANA 5/3/LESTARI (0165/2016),

Universiti Teknologi MARA (UiTM). The invaluable comments by the reviewers on this paper are appreciated by the authors.

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