THE EFFECTS OF DESIGN ON THE MAINTENANCE OF PUBLIC HOUSING BUILDINGS IN MALAYSIA – PART TWO

By Ahmad Ramly, Nur Azfahani Ahmad and Nur Haniza Ishak

Part one of this article covered the background information to this study, and the objectives, methodology and conclusion are detailed here

5.0 Objective of study

a. To understand the link between design and maintenance
b. To study the defects areas
c. To study the defects factors
d. To identify possible solutions.

6.0 Methodology of study

This study is based on literature and field survey. Since residential buildings are more prone to defects due to their permanent and lengthy usage, information and statistics for this discussion have been taken from this case study.
Under this study, a survey has been conducted of 300 respondents that consist of 200 unit occupants and 100 maintenance staff. They represent 36 selected public housing areas in Kuala Lumpur. This study involved 200 housing units and four types of housing i.e. high- and low-rise flats, prefabrication and cluster houses. The focus of the study was to find out physical housing problems before and after occupation. Under the category of before occupation, the study was divided into two parts, first to study site problems and the second to study building structural conditions. The latter has been categorised into three parts i.e. design, construction and materials. Although many other categories and subjects have been inspected in the study, for the purpose of this discussion it will only touch on the subjects that are related to design.
The selection of building components and elements in this study was based on a standard checklist of building elements in the maintenance management, while the classification of defects factors was based on the 'Important Index Formula' (as below). The formula has also been used before, for example by Li, L H & Siu, A (2001), El-Haram, M A & Horner, M W (2002) and Kangwa, J & Olubodun, J F (2003) in their research.

$$\text{Important Index} = \left(\sum_{i=1}^{5} W_i \times f_{xi}\right) \times 100/5n$$

Where W_i = weighting given by the respondent;
i = 1, 2, 3, 4 or 5
f_{xi} = response frequency; f_{x1} = not important and
f_{x5} = very important; and n = total respondents
The respondents in this study have to respond accordingly to the Likert scale of 1 to 5 for all the 12 preliminary identified factors. The level of the scale is 1 = not important, 2 = less important, 3 = important, 4 = quite important and 5 = very important. After computing, the six highest percentages of factors were chosen. They are design, choice of materials, construction, uses of facilities, maintenance and vandalism.

7.0 Analysis and findings

Overall, this study managed to list 39 types of building elements and 4,389 complaints out of 135 types of building defects reviewed. The 39 types of building elements were then grouped into eight components, namely decoration, main structure, internal construction, finishes and fittings, plumbing and sanitary services, mechanical and electrical, refuse chamber and common areas. All the eight groups were also divided into before and after building occupation. Through this study it was found out that 57% of the defects on the components recorded were before building occupation, whilst 43% were after occupation. The following are the defect areas and percentage of defects per component.

No.	*Building Components/Elements*	*Percentage of Defects (%)*
1.	Decoration/Façade (exterior, interior)	4
2.	Main Structure (ground floor, structure, external wall, roof, gutter, downpipe, external door, window and frame)	19
3.	Internal Construction (floor, bathroom ceilings, other ceilings, staircases, bathroom walls, other walls, bathroom doors, other doors)	16
4.	Finishes and Fittings (railing, balcony & staircases ironmongery and kitchen slabs)	7
5.	Plumbing and Sanitary Services (water tank, water closet, pipe for water supply, sanitation, sewerage, toilet apparatus)	15
6.	Mechanical & Electrical (lift, wiring, fire fighting)	11
7.	Refuse Chamber (refuse funnel, chamber & shaft)	8
8.	Common Areas (balcony, corridor, family area, access)	20

Meanwhile, based on six types of defect factors, this research has found out that 30% of the complaints are for design, 17% for materials, 15% construction, misuses of facilities 18%, poor maintenance 15% and vandalism 5%. When the choice of materials is added as the result of design selection, then the total percentage for design defects are 47%.

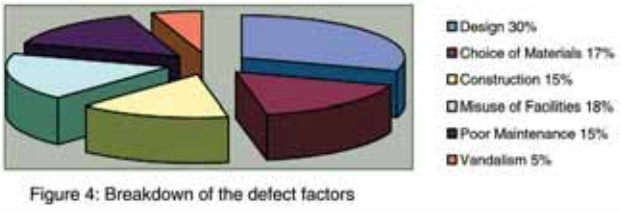

Figure 4: Breakdown of the defect factors

Figure 4: Breakdown of the defect factors

8.0 Area and condition of defects

Design defects are very expensive mistakes. Once such a designed building has been constructed it becomes expensive to rectify or modify. Furthermore, it is not normal practice in this country that a designer will be asked to bear the cost for any defects that lead to many repairs or maintenance difficulties. It seems that a designer is always free from any of his design faults once the building has been completed and given the certificate of fitness. He/she can only be sued if a major accident occurs or the building collapses as a result of the designer's negligence. In fact, in real life very few people realise that a building could have been designed with defects. They are only aware of the problems after the building has been occupied or once maintenance works have started. Although sometimes the client and maintenance manager were invited to the design briefing session, they were unable to give many constructive comments due to two main reasons. First, the session was held in a very limited time frame and in an un-encouraging environment. Second, the said design is seldom given to the client and maintenance manager for further scrutiny. Of course, users or consumers have never been called for such sessions. In fact they have to accept whatever design is being given to them. These have led to more repair works, modifications or renovation after users have taken possession of the said property or building.

In terms of maintenance, there are four sectors can be easily linked to the results of design. First, the main fabric – walls, floors, roofs, doors and windows; second, internal finishes – ceiling and wall finishes as well as floors. Third, special design features – design and decorative elements for the doors, windows, glass, air vents, special face bricks etc. Fourth, cleaning and housekeeping – all building components. In most cases, main fabrics are the major areas that give problems to the maintenance works, especially if the defects occur at the exterior parts of the building. This will expose that part of the building directly to the climatic changes, pollution, sun and rain as well as to the forces of the wind. Following are some examples about the link between design and maintenance problems:

Wall and opening – exterior walls as the building façade has great influence on the aesthetic values of the building and its market price. A lot of effort has been put in by the designer to make the building more attractive at first glance. In doing so, many decorative elements, building's envelope or exterior treatments are given to the building façade. In fact, there is nothing wrong with good looking buildings provided that consideration has been given much earlier as to how to maintain the buildings so that they are always at an acceptable standard and condition. This is because all the details need very special care and proper cleaning. The higher the buildings are built, the more easily they deteriorate and the more difficult they are to maintain. Other than climatic influences, the buildings are exposed to dirt, dark spots and can be a favourite place for nesting birds. Such buildings are easily prone to paint fading and peeling off and the growth of moss and creepers. Once the façade is damaged, it requires not only cleaning works but also repainting.

For buildings using bigger or more glass panels for external walls, the interiors are subject to uncomfortable temperatures and they need air conditioning to stabilise the condition. Here, workers not only have to keep the walls clean but to keep the air-conditioning working as well. It is seldom that buildings with glass panels are provided with any form of canopy or sunlight protection devices. Therefore, external parts of the wall are extremely exposed to wind, rain and sunlight and after some time parts of the panel's joints can become loose and cause leakage.

Floors – there are many types of building materials that can be used as floor finishes and the basic one is cement render. The most common floor materials are marble, terrazzo, tile, mosaic, parquet and vinyl. Due to heavy usage as passage areas, floors are considered to be the most frequently damaged components. Therefore, they need to be designed based on their actual usage in the building. For example, heavy-duty materials are more recommended for factory floors as compared to shopping complexes or residential buildings. Unfortunately, some factories are provided with vinyl floors. Since the life-span of vinyl is very short and it gets dirty easily it requires frequent scrubbing, polishing and replacement. To avoid peel off, vinyl floors need to be properly installed. When wood is used as flooring, such as parquet or wooden planks, they need more rigid treatment to protect them from decay by dampness, insects and white ants. Floors can easily crack if a designer fails to provide sufficient expansion joints, mostly due to temperature changes that cause reinforcement bars in the concrete to expand and contract. Cracks and drops of floors at ground level are normally due to the ground having not properly settled or floors being designed without sufficient reinforcement.

Roof design – the roof is one of the most difficult parts to maintain or repair and can be unsafe to work with. Some of the major defects are roof leakage, water seepage and roof materials blown away by wind. When buildings are constructed high, maintenance and repair works become more dangerous especially to the pitched roofs. Sometimes, defects on flat roof designed buildings are caused by the growth of mosses or small trees, whilst leakage and water seepage happens on flat roofs due to a lack of gradient for rainwater to flow down to down-pipes or due to pipes being blocked or under size. Design of pitch roofs with sufficient overhang seems to be more practical for the Malaysian climate as compared to flat roofs and by having gutters fixed to the pitch roofs they will function better. Gutters will contain the water and run it off to ground through down-pipes. These will automatically avoid external walls getting wet by rainfall or splashes by the wind. Although pitch roofs are a more practical solution for the Malaysian climate, they are difficult to maintain for high-rise buildings unless there are walkways designed surrounding the roofs for maintenance people to place their ladders or work platforms.

Other features – there are many other building elements exposed to defects due to faulty design. Although they are small in size, such as doors, windows, louvres and handrails, their number in the building is numerous. Any mistake in designing them will be repeated throughout and need a lot of money to rectify. One simple example is wooden doorframes. Most of the present door-frame designs have not been fitted with heels, but they are embedded direct into the floor or at ground level to the cement screed. Two common defects normally occurring are decay due to attacks by white ants or moisture or, in the case of bathroom door-frames, rotting due to dampness or by direct water splash. The same things also happened to wooden window-frames when they were installed in exterior walls of high-rise flats. Here, the frames deteriorated due to rainwater and sunlight, whilst handrails in the residential buildings are damaged because residents use them for drying clothes, carpets and other wet materials. Of course, users cannot be blamed for such damage since they are not supplied with drying areas within their living units.

9.0 Conclusion and suggestions

Design defects can possibly be avoided by three main methods. First, promoting good design team, second, by research and thirdly, by using feedback and records from maintenance managers.

Good design teams – the designer needs to consider that he alone is not sufficient to provide good design. Views from others are also important in addition to the training he has received. This professional co-operation in most cases will strengthen the actual building needs and create good rapport among the building professions. In fact, a designer can start forming his design team with appropriate members once he formulates the design brief. Engineers, planners, surveyors, economists, sociologists, maintenance officers, building materials suppliers, etc. can become part of his design team and they can be appointed based on design necessity. Some might be appointed throughout the project, but some for certain stages only. Their participation can be in two ways. First, to give input based on the client's needs, and second, to give constructive comments based on the completed design.

Research – can be used to improve building design. First, the designer can utilise any new inventions of construction tools, building materials and construction techniques. Second, to look back at whatever designs have been used in the past as the basis for measuring mistakes made by others or himself and to find ways for improvement. For these purposes a designer can set up his own research team or utilise others' research results.

Feedback and records – the maintenance manager or his staff are capable persons to give constructive comments and design input. During their service, they are supposed to collect data and keep proper records regarding the performance of the building under their jurisdiction. Some of the common defects, related to design, to be recorded are users' dissatisfaction over certain design areas, poor detailing, wrong choice of materials, inadequate provision for expansion joints or movement, under size design, irregular building shape, unsuitable positioning of building services and insufficient space or facilities required by building users. Therefore, a designer should not repeat any mistakes which have been recorded by the maintenance management.

Of course, in getting good and proper building performance records, a building manager or his staff should be trained maintenance officers who know their works well and should be able to carry out proper building inspection works, such as building condition surveys and building pathology for identifying defects and remedies. Presently in the practice this person mostly is trained under the building surveying course, upon graduation from which they will be known as a building surveyor building engineer. Their training and knowledge in designs, building materials, structures, building laws, building services as well as maintenance is a good asset for building owners or developers for ensuring better building and maintenance performance. In Malaysia, the profession of building surveyor is a recognised building professional by the Government Public Service Department (J. P. A). It is also one of the divisions under the Institution of Surveyors Malaysia. In 1967, the profession was registered under the General Practice Surveyor and governed by the Surveyors Act, No. 67 of 1967.

• Further information from Dr Ahmad Ramly, Faculty of the Built Environment, University of Malaya (e-mail: drabr@msn.com), Nur Azfahani Ahmad, Faculty of Architecture, Planning and Surveying, University of Technology MARA (e-mail: paniyama@yahoo.com) and Nur Haniza Ishak, Faculty of the Built Environment, University of Malaya (e-mail: niza_alambina@um.edu.my

References:

Ahmad R (1989): A Study on Building Problems in the Management of Public Housing Buildings in the Kuala Lumpur City Council Housing Schemes. Unpubl. Master Degree Thesis, UTM, Skudai, Johor.

Ahmad R (2001): Building Defects and the Source of Its Problems. The Malaysian Surveyor. Professional Journal of The Institution of Surveyors, Malaysia. 36.1 1st. Quarter 2001 ISSN 0127-4937. Publ. ISM, P Jaya

Arditi D & Nawakorawit M (1999): Designing Building for Maintenance. (Edit. Quah L K) Facilities Management and Maintenance. Publ. McGraw-Hill S'pore

Barritt, C.H.M. (1982): Architectural Design Procedures. Publ. Longman, Lond.

BOMI Institute (2003): Building Design and Maintenance. http//www.bomi-edu.org/12061.html

Broadbent, G & Ward, A (1969): Design Methods In Architecture (Edit). Publ. Lund Humphries, Lond.

Cartlidge D P (1976): Construction Design Economics. Publ. Hutchinson & Co, Lond.

Chanter B & Swallow P (1996): Building Maintenance Management. Publ. Blackwell Science. Lond.

El-Haram, M A & Horner, M W (2002): Factors Affecting Housing Maintenance Cost. Journal of Quality in Maintenance Engineering. Volume 8 Number 2, 2002 pp. 115-123.

Freedman J L (1979): Crowding and Residential Design. Aiello J R & Baum A (Edit), Publ. Plenum Press, NY

Girardet, H (2001): Cities as Super-Organisms. http//www.oneworld.org/guides/the city/super organisma

Gropius, W (1970): Scope of Total Architecture. Publ. Collier Books, NY

Hanson, K (1969): Design from Linked Requirements in a Housing Problem. (Edit. Broadbent G & Ward A) Design Methods in Architecture. Publ. Lund Humphries, Lond.

Kangwa, J & Olubodun, J F (2003): An Investigation into Home Owner Maintenance Awareness, Management & Skill-Knowledge Enhancing Attributes. Journal of Structural Survey. Volume 21 Number 2, 2003. pp. 70-78.

Li, L & Siu, A (2001): Privatising Management Services in Subsidised Housing in Hong Kong. Journal of Property Management. Volume 19 Nimber 1, 2001. pp. 37-49.

O'Leary, A (2003): New Building That Leak. http://www.dcd.com/oleary_nd.html

Sharma, S C (1998): Inspection Quality, Control and Reliability. Publ. Khanns Publishers, Delhi

Sommer, R (1972): Design Awareness. Publ. Rinehart Press, San Francisco

Stone, P A (1980): Building Design Evaluation. Publ. E & F N Spon Ltd. Lond.

Wilson A (2002): Construction IAQ Management: Job-Site Strategies for Ensuring a Healthy Building. Environmental Building News. Publ. Building Green, Inc.