Service Life Planning for Affordable Housing Design -

A Challenge to Malaysian Construction Industry

Siti Hamisah Tapsir[1] *and Fathoni Usman*[2]

Universiti Teknologi Malaysia Kuala Lumpur

Abstract

Traditionally the construction industry has been expected to provide buildings and constructed assets that are of quality finishes, cheaper, faster to build and durable. With the rising of technology and concern for environment, increasing attention is given on sustainability.

As the overall performance of building relies on the service life and performance of its component and materials, research on method for predicting the service life of construction component and materials is on going globally. Balance quality and sustainability to attempt affordability in residential housing is prior challenge to the construction industry.

This paper will describe roughly condition of local housing industry and the global issue of sustainability in line to the ISO on service life planning. Theoretical approach to estimates the service life of building component and ongoing research on service live at Universiti Teknologi Malaysia will be the bridge to occupy the challenge.

1. Introduction

Construction industry contributes to a major amount of the nation's economy. It is well established that construction industry is the first to be affected during economic downturn and the last to make progress when the economy recovers. Despite the economic issue that is not within the control of the industry, there are other aspects that are controllable by the industry that is quality, cost and speed of construction.

Another aspect that is within the control of the industry is to go step further by providing sustainable building. Sustainable buildings are those that economically reasonable and affordable, service life longer than design life and do not harm the environment and the future generations. This is in fact in line with the ISO concept where proper planning of

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[1] *hamisah@utmkl.utm.my*

[2] *fathoniu@hotmail.com*

the service life of the buildings and constructed assets are carried prior to the construction stage.

The first Malaysia Plan was implemented in 1966, during that time the first formal and structured housing programs were undertaken to provide low-cost housing. In the second Malaysia Plan there are 120,071 units of housing completed between 1971-75 and 671,142 units between 1991-95 (6th Plan). During the 7th Malaysia Plan, the country targeted to build about 800,000 units of houses for its people. Out of that, 585,000 units (or 73.1 %) were targeted for the low and low-medium income categories. The 8th Malaysia Plan has a target of another 615,000 units to be built between 2001 and 2005, out of which about 400,000 have been completed during the first two years of the 5-year plan period, mainly in the low and low-medium cost categories [1, 2].

2. Sustainability of Affordable Building

In 1987 the World Commission on Environment and Development defined sustainability as meeting the needs of today without compromising the ability of future generations to meet their own needs. The definition must balance the future safeguarding of three interdependent areas: social, economy, and environment [3].

The entire lifecycle of buildings are planning and design, procedure and construction, use and operation, maintenance and reparation, rehabilitation, and finally dismantle or reuse or demolition and recycle. Building products should, as far as possible, be reusable and materials recyclable. An effective service planning should include life cycle costing, life cycle assessment and building audit. **Figure 1** represents the complete cycle of sustainable construction activities.

Sustainable buildings define as buildings with service life exceeding the design life, meets eco performance requirement, and do not affect what we have today. Sustainable building aims to consider the environmental, economic, and social impacts of a construction project as an integrated whole rather than looking at these areas individually.

3. Service life planning

Service life is defined as life span after installation or construction during which a building or its components exceeds the specified performance. Service life planning addresses the design of a structure or a building with a view to its operation through the whole of its operational life. It means looking at the long-term performance and overall operating costs at the design stage. [4].

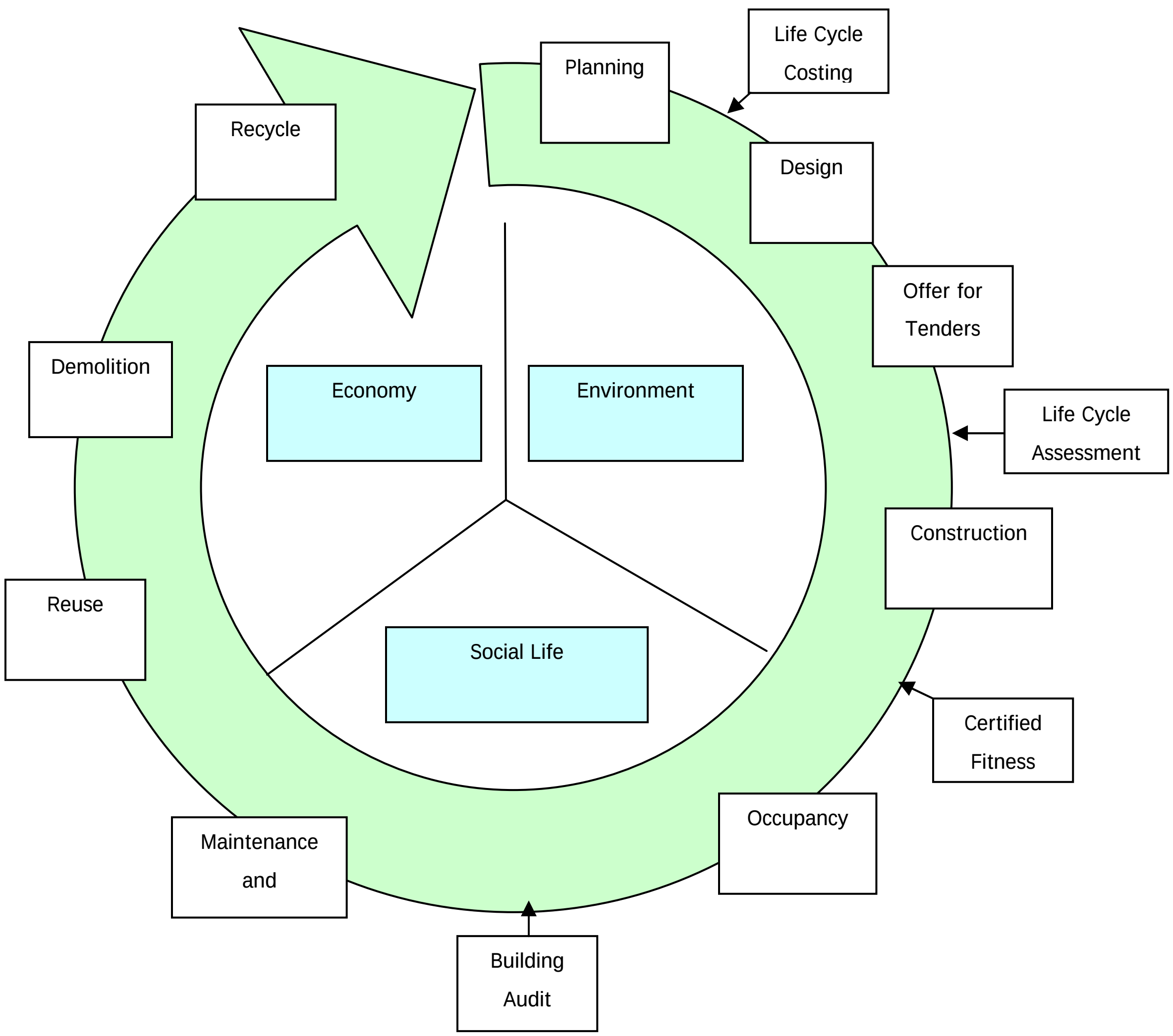

Figure 1. The whole step of construct a sustainable building

The ISO 15686 defined the service life planning as a design process, which seek to ensure that the service life of a building will equal or exceed its design life, while taking into account the life cycle cost of the building [6]. Service life planning should be carried out at design stage and included in the tender. This will allow the client to have access to systematic and control costing of owning the respective building from the inception to end of its life because high proportion of maintenance cost is set by the time the building is completed.

Service life planning constitute of service life prediction, life cycle costing, auditing and estimating timing of necessary maintenance and replacement. The outcome will be a series of predicted lives of components, projection of maintenance and replacement needs, timing/scheduled costs to assist future maintenance and replacement operations, selection of the optimum quality and design practice. Life cycle costing is essential in achieving sustainable development through assessment of the economic consequences of using certain building materials, system or component in comparison with the expense of substituting alternatives which may offer better staffing efficiency, improved performance and newer technology.

4. Service Life Prediction from Reference Service Life to Estimated Service Life

Service life prediction allows effective reduction cost of ownership based on maintenance planning and value engineering. It is done through data on life span of its components, effect of environment and location. The bridge between Reference Service Life (RSL) and Estimated Service Life (ESL) is the object of researchers all over the world, members of CIB W80 - RILEM 175 SLM suggested that each method should be classified in one of the following categories [10, 13]:

1. Factorial Method.
2. Probabilistic Methods.
3. Engineering Methods.

4.1. Factorial Method

In ISO 15686-1 the concept of Reference Service Life (RSL) is defined as “service life that a building or parts of a building would expect or is predicted to have in a certain set of reference in-use conditions”. The Factor Method as used in ISO 15686-1 is used to modify an RSL to obtain an estimated service life (ESL) of the components of a design object. The factor method is carried out by adjusting the RSL, which considering a number of factors. These factors represent [4, 7]:

$ESL = RSL * A * B * C * D * E * F * G$

where:

A. Quality of component

B. Design level

C. Work execution level

D. Indoor environment

E. Outdoor environment

F. In use condition

G. Maintenance level

In the design situation the factor method can be used just as a reminder to the designer to adjust a given RSL. The factor method was developed as a tool to support service life prediction in cases where there is a lack of sufficient or reliable data. The ISO 15686-1:2000(E) indicates the limitations of the factor method. Researches on Durability of Building Components developed at the DISET - Polytechnic of Milan stated that the factor method seems to simplify too much the complexity of factors affecting degradation processes.

4.2. Probabilistic Method

Probabilistic Method is a different kind of approach, which is under development in order to take into account the actual complexity of degradation process. In these methods degradation is generally regarded as a stochastic process, for each property during each time period, a probability of deterioration is defined. These methods require fairly complicated inputs in the form of probabilities, which are not easily estimated, and require quite some effort to be put in. The efforts needed to use these kinds of methods in real projects made probabilistic method economically usable only in large projects.

4.3. Engineering Method

Moser K. and Edvardsen C. have proposed Engineering Design Method in 2002, a principle solution that can be applied to the factorial method for standard cases as well as to other set-ups employing mathematical relations for service life [13]. This is achieved by not using plain factors but probability density functions instead. These are established using reliable and understandable engineering techniques.

Data acquisition is the first step should be completed. After that Delphi method is used where panel of experts is called together and asked on their professional opinion on the distributions of the different factors, their type of distribution, their mean values, and standard deviations. In ISO/DIS 15686-4, these triple estimates for each factor A to G can be represented by a β-distribution and standard deviation σ. The product of the estimates can be calculated by carrying out a Monte Carlo simulation. Finally, The output from the Monte Carlo simulation will form a distribution and give an average value and a standard deviation [9, 13].

The service life can be calculated from damage functions as a dose-response function and recent environmental data. When the pollution data or meteorological data are available on a regional scale as a data field, the service life can be calculated as a field on GIS based map. Dose-response function it self is the relationship between the deterioration rate and the levels or loads of pollutants in combination with climatic parameters [14].

5. Malaysia affordable housing: Implementation of Service Life Planning

Price of low cost housing was fixed at a maximum of RM25,000 per unit. The current revised maximum price of RM42,000 for low cost housing development is still being cross-subsidized and at best, sold at cost. Allocating a minimum 30% quota of their developments for low-cost houses. In certain location, this quota could be as high as 50% [1]. Those were challenges for developers in order to fulfill the government policies.

Continuous consumer complaints on poor workmanship, shoddy building materials and structural defects point to low cost housing [15]. The National Property Information Center (NAPIC) reported that as at Quarter 3 of 2003, 54,265 units of residential properties remained unsold after having been in the market for more than 9 months [1]. Cross-subsidized from other higher cost property, quota, location and low buying demand are major constrains to have a low cost housing.

The required design life is achievable within the project constraint, i.e. budget, time, performance, maintenance and site requirement. Service life planning began agreement between owner and designer with identification of the required design life of building and its functional performance, measurable functional performance criteria and unacceptable functional performance that requires replacements and identification of building components that needs repair and replacement during the design life.

Buildings and their components should be identified as either replaceable or permanent. In the case of maintenance, design for long service life is better than design for reusability. In the other case, adjustment of either the budget or service life requirements may be necessary. Reduction in initial cost by lowering component's quality may increase the maintenance cost.

During detailed design stage including selection of materials and components, there may be limited choice of components and materials availability. Components should be assessed for compliance with performance requirements. Performance deteriorates at a rate depending on the environment, the design of the building, components and installation, selecting optimum qualities, use of tools such as value engineering and life cycle costing, the materials, the skill and quality of site work, maintenance and usage.

Materials and components vary in their reaction to agents of degradation and some materials may be unsuitable even on the initial inspection. If local conditions, environment during construction, materials, skills and levels of workmanship do not achieve the manufacturers recommendations or codes of workmanship standards, the effect on the service life should be considered.

The sustainability must balance with the quality of construction emerge to the future safeguarding of three interdependent areas: social, economy, and environment. Setting the goal for sustainability of affordable housing is outlined as below.

1. Social Life. Public housing has to meet today expectations for better internal living spaces as well as a pleasant external environment for enjoyment and social interaction. A housing unit must also be able to cope with the different spatial needs associated with the growth and aging of occupants, and changes in family structure.
2. Economical Considerations. With the tight budget, high performance has to maintain through careful design to ensure quality of the living environment, efficient construction process, low maintenance and efficient operation.

3. Ecological Saver. It is intended to protect our environment so that our future generations can also enjoy it. Steps taken would be:
    a. The use of recycled materials.
    b. Recycling demolition materials and reducing waste production.
    c. Prefabrication.
    d. Good construction management.

5.1. Ongoing Research on Service Life of Building Components at Universiti Teknologi Malaysia

Research on service life of building component is recently ongoing at Universiti Teknologi Malaysia. Conditional rating approach is used in data collection of building's components. As building components are exposed to degradation agents such as weather, the surrounding environment and environmental pollution, the service life of these components affected differently. There are 22 components of building to be collected at 21 selected location around Malaysia. The locations are derived into 6 different environmental exposures from 7 different types of buildings. The SO_2 data, yearly precipitation, acidity and time of wetness data are collected. Statistical analysis will be performed to generate function that can estimate the service life of building component for local climate.

The objective of the research is to propose the service life functions as dose response function of degradation factor for local environment. The service life of these components can be used to make life cycle assessment of local buildings more accurate. Thus, the balance for quality and sustainability can achieve.

6. Conclusion

In order to balance between quality and sustainability, service life planning have to be implemented at early stage of construction. Data collection is essential to ensure reliable results on the predicted service life. To achieve this conclusion, gathering of useful data and computer integrated knowledge system for building design and maintenance is critical.

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