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STRATEGY FOR SUSTAINABILITY IN AFFORDABLE HOUSING - A CHALLENGE TO MALAYSIAN CONSTRUCTION INDUSTRY

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Summary

Traditionally the construction industry has been expected to provide buildings that are economical, faster to build, durable with quality finishes. Now days, a balance in quality and sustainability to achieve affordability in residential housing is a major challenge to the construction industry. Service life planning acts as a bridge connecting sustainability and affordability in a building. This is in line with the ISO concept where proper planning of service life of buildings is taken into consideration prior to the construction stage. At Universiti Teknologi Malaysia, a tool for service life planning of buildings for local environment is being developed. The service life planning tool incorporates factors that affect building performance to predict the service life of the building components, economic assessment i.e. life cycle costing of the building and qualitative assessment of the building sustainability.

1. Introduction

Building process has often been described as a highly complex process because of the number of disciplines involved during the conceptual, construction and design stage. Once completed, environmental change and usage of the building soon test the quality of the design and workmanship as well as the suitability of material used through out the life cycle of the building. During its life time buildings require maintenance, components replacement and rehabilitation. Figure 1 shows typical life cycle of buildings.

With the emergences of latest technology and concern for environment, increasing attention in construction industry is given on sustainability. Balance in quality and sustainability in an attempt to produce affordable and comfortable residential housing has become a major challenge to the construction industry.

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 balances the future safeguarding of three interdependent areas: social, economy, and environment (Sjöström, 2000). Sustainable building is defined as building with service life exceeding the design life, meeting eco performance requirements without distressing what we have today for the future generation. Sustainable buildings aim to take into consideration the environmental, economic, and social impacts of a construction project as an integrated whole rather than looking at these areas individually.

Service life of buildings is affected by several factors such as exposure to the weather, environment, workmanship, building materials, usage and level of maintenance. To certain extent these factors accelerate aging process of these buildings and thus shorten its life span. Understanding the effect of these factors enable service life planning be drawn through service life prediction, life cycle costing, life cycle assessment and building audit. Through optimizing the service life of the building components and its materials, operational and maintenance cost can be reduced. In many countries service life planning are not given priority due to several reasons.

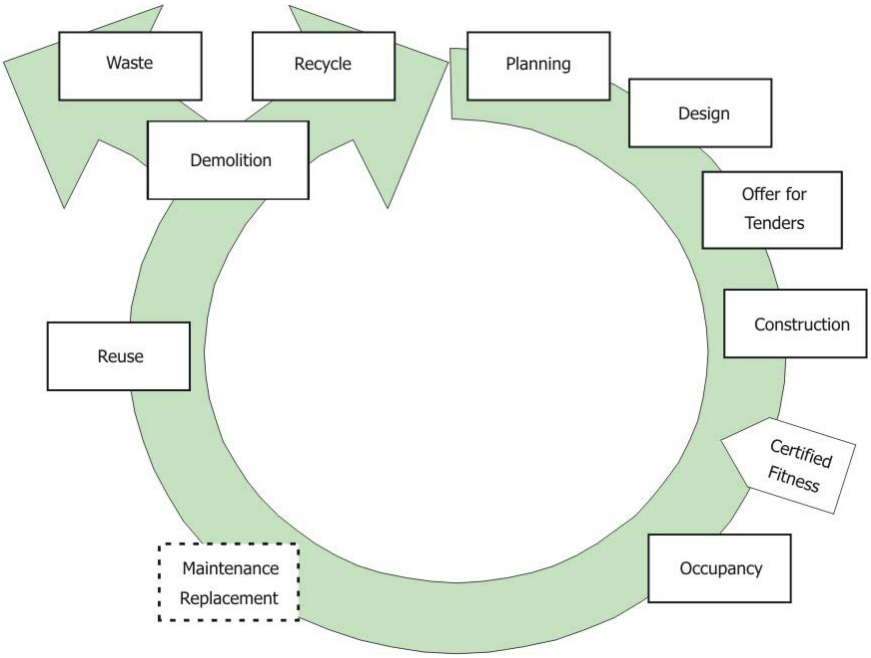

Figure 1 Typical life cycle of construction activities.

2. Challenges to the Malaysian Construction Industry in Achieving Sustainable Housing

2.1 Service Life Planning

An effective service life planning should include service life prediction, life cycle costing, auditing and providing schedule maintenance and replacement of building components. Service life planning allows effective reduction cost of ownership based on selection of materials during design, scheduled maintenance and replacements. The basis for material selection is on data of life span and its performance, effect of environment and location. The objective of service life planning is to ensure, as far as possible, that the estimated service life of the building or component will be at least as long as its design life.

Lack of service life planning accounts for inefficient building maintenance in most housing in the country. For example, maintenance services of most stratified properties and high-rise apartments in Malaysia are provided by the housing developers themselves or by their appointed subsidiary companies without any service life aspect taking into consideration. Housing Buyer Association (HBA) report a 19 % of complain on maintenance of building caused by lack of maintenance. Figure 2 show the type of complaints reported by owner to the HBA. Study on low cots residential housing in Malaysia found that most of these residential buildings are occupied without regular or scheduled maintenance (Tapsir S.H, 2001).

2.1.1 Service Life Prediction

Service life planning introduces the forecasting of service life into the design phase. It includes definition of the design service life of the building, forecasting the estimated service life of building components and using the estimated service life as a decision criteria for selecting alternatives during the design, in order to minimize life cycle costs (John VM, 2002). Estimation of the service life at the design stage allows consideration of the specific site. It will assist planning of future maintenance operations, selection of the optimum specification and design, and avoidance of waste.

Study on service life prediction for building and building components is being carried out by Universiti Teknologi Malaysia. This study is a part of larger study on life cycle costing for affordable housing research project under Ministry of Housing Malaysia. The objectives are to determine the degradation factors, which are involved in building deterioration for several different locations, and to take into account the environmental and other factors in calculation of life cycle costing of buildings.

From the study found that interactions between building materials and pollutants are very complex and many variables are involved. Deposition of pollutants onto surfaces depends on atmospheric concentrations of the pollutants and the climate and microclimate around the surface. Once the pollutants are on the surface, interactions will vary depending on the amount of exposure, the reactivity of different materials and the

amount of moisture present. In this study, only the pollutant and the macroclimate parameters are took in account.

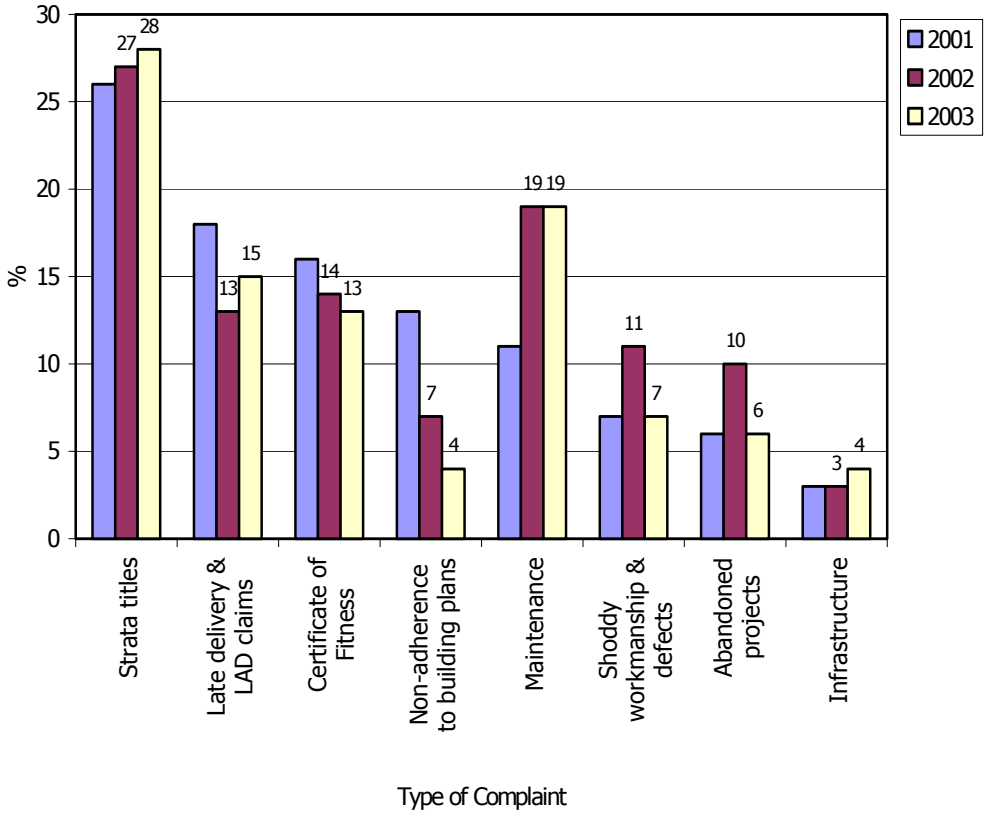

Figure 2 Type of complaint reported by owner to the HBA.

As an example sulphur dioxide, SO_2 is connected with atmospheric corrosion and considered as a major contributor to acid rain. SO_2 concentrations have declined during recent year especially during 1996 to 2000 in Malaysia. This phenomenon occurs due to the economical crisis that hit most of Asian countries. Many factories reduced their operation and production. Other reason is the improvements to industrial processes and combustion techniques used in factories.

SO_2 is easily adsorbed on material surfaces, and the deposition may be wet or dry. The transformation reactions may take place both in gas phase and in aerosol phase. SO_2 exist for quite a few materials in the dose response functions. For most of the materials, SO_2 is the main corrosive agent in the air (Haagenrud, 1997). In absorption process in to the exposure building components, moisture conditions are of vital importance and strongly correlated with relative humidity and temperature. The yearly average concentration of the SO_2 for Malaysia's peninsular have represented in the Figure 3.

Relative humidity, precipitation and temperature are very correlated with the moisture. The acceleration of deterioration of the building components is depending on the moisture on the surface of the building components. The moisture or wetness of surface depended not only on relative humidity but also on other parameters such as salt deposition, sunlight radiation, wind, and absorption of ambient heat (Chotimongkol). With the relative humidity > 50% for all region in Malaysia and average temperature 27^{o}C, it was moist enough with average yearly fractional time of wetness (TOW) equal to 0.783 to make moisture layer on the surface of the building component will reside a bit longer and absorption into the building components will become more effective.

Those data are preliminary finding of study. A lot of data was required to be used in according to forecast the service life of building components. Lack of data on service life of building components, in depth awareness on factors affecting service life by the construction players, lack of awareness on the need of to preserve the environment and lack of encouragement from the policy makers contribute to service life prediction being practice in the construction industry. Similarly life cycle costing, life cycle assessment and building audit are not being practice in the country for the same reason as service life prediction.

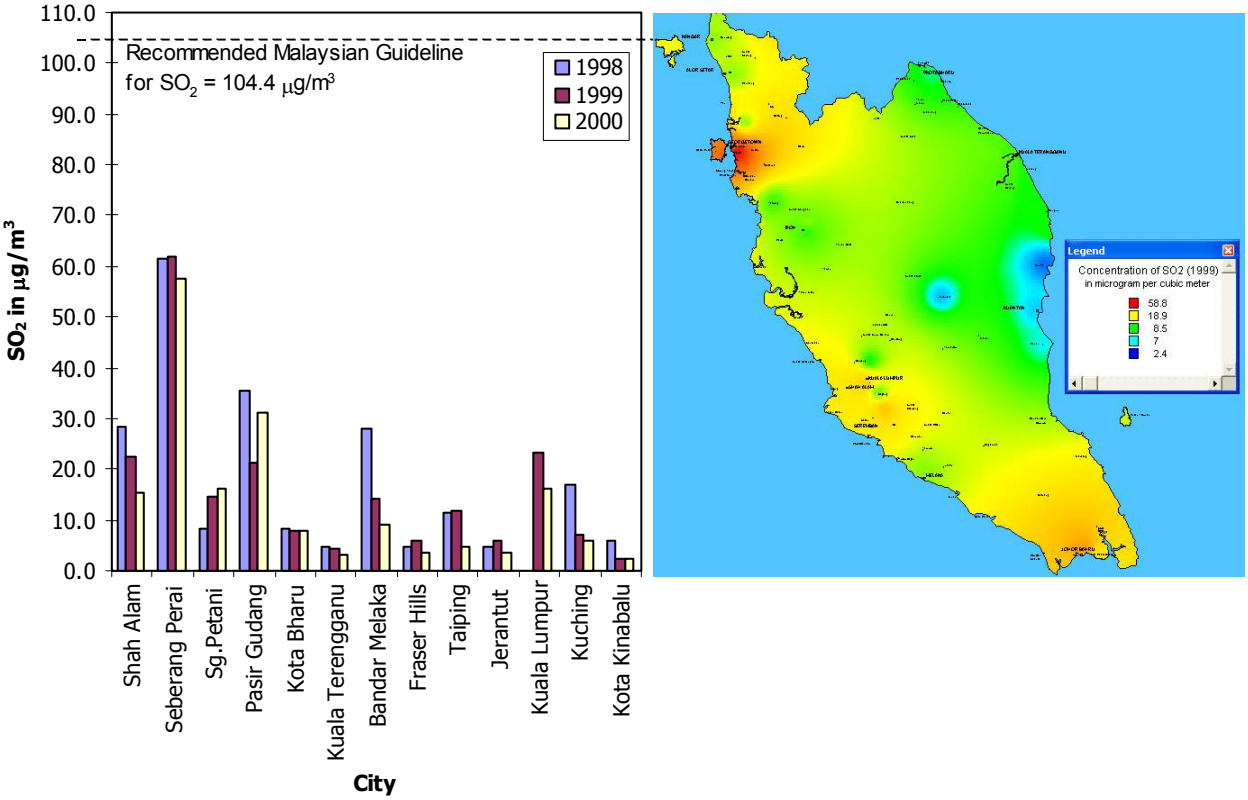

Figure 3 Average yearly SO_2 concentration at Malaysia's Peninsular in $\mu g/m^3$

2.2 Labor, Materials and Infrastructures

Labor, material and infrastructure costs account to more than 60% of the cost of a house. Any movement of these costs will have an impact on house pricing. Keeping these costs low is a big challenge to the industry. The housing industry in general adopts conventional method of construction and for this purpose relies heavily on foreign workers. Contrary to popular belief that developers use foreign workers because of lower wage, these workers, particularly skilled and semi skilled laborers.

3. Strategy on Implementation and Predicaments

3.1 Policy makers involvement

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 beginning to end of its life because high proportion of maintenance cost is set by the time the building is completed. The service life of a building component is important to estimate an exact live cycle cost of the building. The outcome will be a series of predicted lives of components, projection of maintenance and replacement needs, scheduled costs to future maintenance and replacement operations, selection of the optimum quality and design practice.

Policy makers through tax initiatives and levies during the tender award process could enforce Service life planning. The policy maker have to encourage the developer to delivering buildings and structures that provide greater satisfaction, comfortable and value to people. Policy makers have to exploit events to promote awareness and understanding of sustainable construction to people in enhancing and protecting the natural environment and to the construction parties by enhancing awareness on sustainable construction through cost and benefit.

The policy makers have work towards making industrialized building systems a priority in the agenda for the construction industry. Academic institution with government bodies could be elaborated in research on building materials and industrialized building systems to introduce alternative building materials to reduce costs, more efficient construction process and less labor dependent in providing more affordable housing for people.

3.2 Implementation

Service life planning has to begin with agreement between owner and designer to generate same vision and perspective in identification of the required design life of building and its functional performance. They must have same vision on measurable and unacceptable functional performance that requires replacements and identification of building components that needs repair and replacement during the design life. Figure 4 show the implementation of service life planning and the assessment of the building requirements to gain the sustainability to the building construction.

Maintenance is viewed as a set of actions that restore performance levels of components to acceptable values, thus the performance concept is very important in the maintenance process. Presently, maintenance services of most stratified properties and high-rise apartments are provided by the housing developers themselves or by their appointed subsidiary companies who lack the competence of qualified management resulting in monotonous maintenance work and unsatisfactory services. By implement the service life planning, the way and the structure of maintenance program have to be changed. Either provided by the government agencies or by developer or other private bodies.

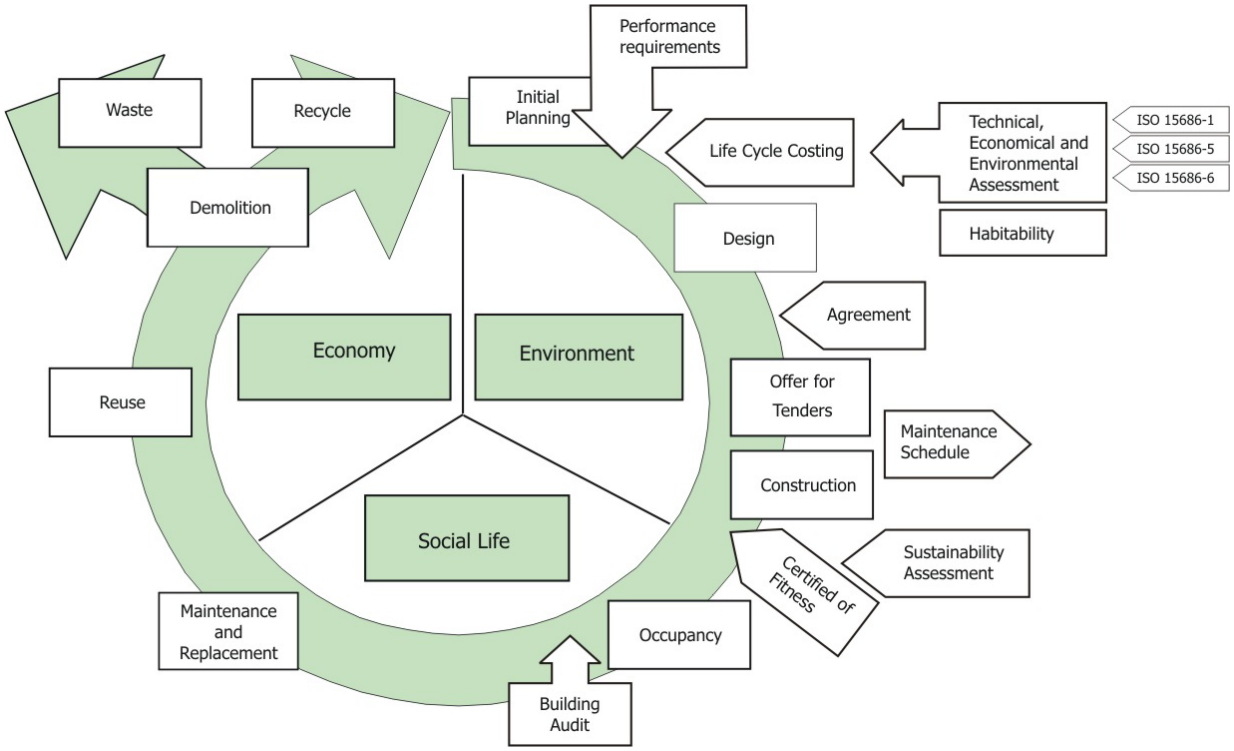

Figure 4 Implementation of service life planning in life cycle of building to achieve sustainability

3.2 Data Collection and Service Life Planning

The technical, economical and environmental have to evaluate and assessed to provide service life prediction data. Materials and components vary in their reaction to agents of degradation and the performance of building components deteriorates depending on the environment, design, components and installation, materials, quality of site work, maintenance and usage. 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. Buildings and their components should be identified as either replaceable or everlasting. Reduction in initial cost by lowering quality of building components may increase the maintenance cost. Manufacturers in this position have to provide the life span of their products. With availability of the data, service life of building components will be predicted and service life planning can be implemented to the building. Research on effect of environment and its atmospheric pollutant to the building materials and building components by academic institutions, private bodies and government agencies could be very applicable to provide data for service life prediction.

3.3 Predicaments

Sustainability is a global concept for answer global problems, unfortunately its application in societies or regions results in very diverse agenda 21 for each country. In developing countries there are several

predicaments barriers to implement the sustainable building like low environmental awareness, lack of service life data and experts on this field. Also, the implementation of service life planning into the thinking of building designers has the potential to modify the way buildings are constructed, the way land is developed and rethinking in design and planning dramatically. The providing data on life span of building components by manufacturer can have a large impact on the competitiveness of various building materials in the market.

4. Conclusion

Ensuring that the service life planning has to be implemented in building construction especially for affordable housing to provide the need of better settlement for people should not be the responsibility of construction parties alone. For it to be successful and effective, all parties should make concerted effort and contribute towards this objective, including the government and its agencies, manufacturers, developers, contractors, professionals and financiers.

References

Chotimongkol L. Atmospheric corrosion of metallic building materials in Thailand TISTR 196, Phahonyothin Rd., Chatuchak, Bangkok 10900, Thailand pp 1-8

Haagenrud S.E. 1997, Environmental Characterisation including Equipment for Monitoring CIB 80/RILEM 140-PSL SubGroup 2 Report, Norwegia.

ISO 15686-1, Buildings and constructed assets - Service life planning- Part 1: General principles, International Standard Organisation, Geneva.

ISO 15686-2, Buildings and constructed assets - Service life planning, Part 2: Service life prediction procedures, International Standard Organisation, Geneva.

ISO 15686-3, Buildings and constructed assets: Service life planning, Part 3: Performance audits and reviews, International Standard Organisation, Geneva.

John V.M, et. al. 2002, Durability In The Built Environment And Sustainability In Developing Countries, *9th International Conference on Durability of Building Materials and Components (DBMC)*, pp. 1-7.

Sjöström, C and Lair, J. 2000, Performance Based Building – Some implications on Construction Materials and Components, ILCDES 2000 Integrated Life-Cycle Design of Materials and Structures, Helsinki, Finland, pp. 1001-1008.

Tapsir, S.H. 2001, Final Report, Affordable Housing Research Project - Life Cycle Costing Approach for Residential Housing in Malaysia, Ministry of Housing and Local Government, Malaysia, pp. 65-72.

Usman, F and Tapsir, S.H. 2004, General Review on ISO 15686 Building and Constructed Assets – Service Life Planning Part 2: Service Life Prediction Procedures, Workshop on Design Life, Malaysia, pp. 1-4.