A Review on The Critical Influencing Factor for Life Expectancy (LE) and The Life Expectancy (LE) for Malaysian Housing

K Norfarahayu¹, M Hairuddin², A Nor Haslinda¹ and Y Siti Khalijah¹

¹ Depart. of Building Eng. and Construction, Faculty of Civil and Environmental Eng., Univ. Tun Hussein Onn Malaysia, Parit Raja, 86400 Batu Pahat, Johor, Malaysia
² Centre for Dip. Studies, Univ. Tun Hussein Onn Malaysia, Pagoh Higher Edu. Hub, KM1, Jalan Panchor, 86400 Pagoh, Muar, Johor, Malaysia.

Abstract. In 2013, there are two death cases reported due to the broken railing at the Projek Perumahan Rakyat (PPR) flats in the capital city of Malaysia. These cases occurred due to rusting of the balcony railing, which has been neglected in maintenance. These were the evidence of awareness lacking on the need for maintenance, which frequently only be realised at the latter stage of deterioration on house components. The situation aggravated when the house owners do not have any technical knowledge about defects and have zero building construction background, which later on resulting in less to none periodic assessment throughout the life expectancy (LE) of house components. Nevertheless, the absence of Malaysian study on the life expectancy of house components is deemed the centre of the predicament. Therefore, the paper aims to review the critical influencing factor for life expectancy (LE) and the Life Expectancy (LE) for Malaysian housing. Thus, a qualitative undertaking is conducted through multi-layered thematic analysis. As a result, there were eight influencing factors of life expectancy (LE) namely; weather and climate condition; design; maintenance and replacement; the intensity of use; quality of materials and products; technological obsolescence; workmanship; and insects damaged. Afterwards, within 114 number of generic house components, the findings indicated that there were differences of LE for house components; averaging from 14 years to more than 100 years. The particular differences also depend on the influencing factors of LE. These findings were then become the basis for the subsequent research endeavour.

1. Background of research

In a construction project, there are several phases involved, namely, planning, development, and maintenance. The maintenance phase is undoubtedly an extended period, which falls under the scrutiny of the project owner during Defect Liability Period (DLP) (usually 18 months to 24 months) and legitimate house buyers afterwards [1,2]. Maintenance is the processes and services required to undertake to preserve, protect, enhance, and care of the building [3]. The previous study has been concluded that building maintenance practices are lack of a comprehensive maintenance management framework that guides the decision-making processes. Besides that, building maintenance is also able to increase the performance and life span of the building, and it also helps in term of investments’ value [4]. However, according to Alshehri, Motawa and Ogunlana [5], one of the problems in maintenance is inadequate financial [5]. That statement is in coherence with Che-Ghani [6] which indicate that the cost for maintaining a house is relatively high due to poor maintenance practices [6]. Thus, to avoid a massive
flow of money, building maintenance needs to be addressed at the early stage after the completion of the building. Only then it will ensure the optimum performance of the building throughout their lifespan.

In term of house owners, most of them are not aware of the needs of maintenance until it is too late, i.e. when the deteriorated components were severely damaged and exposed. As a result, failure to replace or repair the deteriorated components at the earliest time possible will cause injury to people and further damage to the property. Among others, this was transcended to the tragedies in 2013 on two recorded death cases involving infants falling from 14th and 6th floor of Projek Perumahan Rakyat (PPR) flats in Petaling Jaya – due to a defect of railing [7,8]. Therefore, realising the importance of having a pre-rectification action at early stages, this study seeks to establish the term of references for LE factors and their average LE towards house components for the improvement of housing maintenance in Malaysia.

Nonetheless, due to the lengthy nature of the study, the particular paper only reports on the preliminary study on identification of influencing LE factors for generic house components, and also the LE for each components through literature review. Hence the objectives, the study focuses on three (3) categories of house components, which are structural, architectural, and electrical – which can be assessed using sense perceptions such as vision, hear, touch, and smell [1]. Limitation of sense perceptions is to compensate the nature of house buyer that lack a technical background. Meanwhile, buildings category A (landed houses) which comprised of detached houses, semi-detached houses, terrace houses, and cluster houses were selected as a study parameter [9].

In general, the paper has contributed towards bridging the knowledge gap on factors influencing LE for generic house components and LE for each component in Malaysia. Apart, through the initial qualitative processes, a clear understanding of LE is developed. Which unveiled that the average LE is varied according to the identified LE factors, especially weather and climate condition of the respective country.

2. Life Expectancy (LE)
House components’ life expectancy (LE) is defined as the lifetime or the average number of years that users could expect for the lifespan of the house components, which generally based on certain factors. Some researchers also determined LE as the statistical range of years (e.g. 10-20 years, etc.) of the remaining life of the components before they break, damage, need further maintenance or need replacement [10]. Besides, they also stated that the age of 10 to 12 years is the common starting point of the defects’ visibility throughout the building’s lifetime [10].

A study conducted towards LE was carried out in 2006 by the National Association of Home Builders (NAHB) from United States of America (US). The research has emphasised that the level of maintenance is significantly affected by the LE of house components in the US. Meanwhile, other factors that influence the LE of house components are; changing of styles and technology, exposure to weather and climate condition, the intensity of use, maintenance and replacement, qualities of products and materials, and installation’s quality (i.e. workmanship) [11].

On the other hand, while associating LE with construction procedures and practices, Bakri and Mydin [12] and Mohamad and Annuar [13] stated that, the house floor must be designed at a reasonable height above the ground level to prevent water from creeping into the house. On construction, the earth fillings should be appropriately watered and rammed, and good quality of soil should be used below the floor. Apart, concrete bases from dry bricks or metals, with or without sand and cement/lime should be provided to prevent floor settling. Besides, in term of floor materials, it should also be in good quality, low maintenance, and with minimal environmental effect [12,13].

3. Methodology
The paper serves as an exploratory study by exploring and understanding the central phenomenon of the research through qualitative data. The use of exploratory study is a well-established approach to understand the central phenomenon of a study from multiple sources at various time points [14]. The objectives of this study are to identify the factors influencing the LE of generic house components and the LE of each component through preliminary literature review. Therefore, data collection processes have been divided into two phases which are; (i) the identification of generic house components in
3.1. Phase I: Identification of generic house components in Malaysia

A literature review was carried out to identify the generic house components in Malaysia towards numerous published materials (e.g. journals, magazines, government reports, proper standards and guidelines, unpublished thesis and website document). Through ‘Multi-layered Thematic Process’ (MLTP), house components were collected and analysed based on the basis of a completed house after construction. These were further vetted on components which can be assessed using sense perceptions (i.e. vision, hear, touch, and smell) and as well as its compatibility with the Malaysian housing environment (see Figure 1).

![Figure 1. Multi-layered Thematic Process (MLTP) [1]](image)

3.2. Phase II: Identification of factors influencing the life expectancy (LE) of generic house components and LE of each component

Subsequently, by referring to the checklist of generic house components in Phase I, a critical literature review was carried out to identify the factors influencing the LE of the components and the LE of each them. Data collection for both aspects were also embedded within the MLTP processes in order to present meaningful outcomes. For factors’ identification, layers taken were the factors, the type of house components, and their finishing and associated materials. Meanwhile, LE identification will just screen the information on the life span of the particular components (see Figure 1).

4. Result and discussion

4.1. Phase I: Identification of generic house components in Malaysia

The identification of generic house component in Malaysia was carried out through reviewing established literature such as standards, guidelines, books, published articles, and product magazines and brochures around the globe.

The initial results found that there are 114 generic house components including their sub-components, materials, and finishing. Furthermore, according to the previous studies conducted by Kariya et. al. [15] and Mohammad et al. [16], the generic components were manually analysed and subdivided into several clusters including macro-components, micro-components, and materials. As a result, 10 main house components (e.g. column & beam, etc.), 17 macro-components (e.g. stair, etc.), 24 micro-components (e.g. panel, etc.), and 16 finishes (e.g. concrete, etc.) were identified as generic house components in Malaysia and their references. As an example, the staircase is one of the generic house components which can be assessed through vision (e.g. through eyes-on cracking issue) and touch (e.g. through the hand-on the evenness of tile finishes). Their macro-components are stair (e.g. riser), handrail, baluster,
and landing. Meanwhile, their finishes are carpet, tiles, and laminated flooring. However, the table only shows the main house components, macro components, and their finishes.

**Table 1.** Generic house components in Malaysia

| House Component | Macro component | Finishes | Sources |
|-----------------|-----------------|----------|---------|
| Column & beam   | Concrete        | Wood     | Published literatures: [9,11,15-18] |
| Staircase       | Stair (e.g. Riser, tread) | Carpet | Published literatures: [5,11,17-25] |
|                 | Handrail        | Tiles (i.e. marble, granite, etc.) | Catalogues: Wira Sky Steel Sdn Bhd, Supercool Creative Culture Sdn Bhd, COD Marketing Sdn Bhd, Weng Heng Stainless Steel Sdn Bhd, Wira Wrought Iron & Stainless Steel Sdn. Bhd., Solid-Glass & Metal Industries Sdn Bhd. |
|                 | Baluster        | Laminate flooring | |
|                 | Landing         |          |         |
| Door            | Folding door    | Glazing  | Published literatures: [5,9,11-12,15,17-20,22,25] |
|                 | French door     | Vinyl    | Catalogues: Amax Lifestyle Product Sdn Bhd, Reliance Home Sdn Bhd, Space Kete Sdn Bhd, THC Metal Engineering Sdn Bhd, Tropical Window & door Sdn Bhd, COD Marketing Sdn Bhd, Wira Wrought Iron & Stainless Steel Sdn. Bhd., Honglee Group (M) Sdn Bhd, Solid-Glass & Metal Industries Sdn Bhd. |
|                 | Sliding door    | Metal    |         |
|                 |                 | Wood     |         |
|                 |                 | Fibreglass |         |
| Window          | Casement window | Glazing  | Published literatures: [5,9,11,16-20,22,23] |
|                 | Top hung window | Vinyl    | Catalogues: Amax Lifestyle Product Sdn Bhd, Breezway Window & Door Marketing Sdn Bhd, Reliance Home Sdn Bhd, Space Kete Sdn Bhd, Tropical Window & door Sdn Bhd, COD Marketing Sdn Bhd, Wira Wrought Iron & Stainless Steel Sdn. Bhd., Honglee Group (M) Sdn Bhd, Solid-Glass & Metal Industries Sdn Bhd. |
|                 | Fixed panel window | Metal |         |
|                 |                 | Wood     |         |
| Floor           | Wood            | Tiles (i.e. marble, granite, porcelain, etc.) | Published literatures: [5,9,11,13,17-20,22-23,25-26] |
|                 | Concrete        | Laminated flooring | Catalogues: Orion Contract Sdn Bhd, Lumber Mart Sdn Bhd, Netwood, Sugawa Lonwood Sdn Bhd, Swoods Sdn Bhd. |
|                 |                 | Resilient (i.e. Rubber, plastic, PVC, Linoleum, Vinyl) |         |
|                 |                 | Carpet   |         |
| Wall            | Internal wall   | Facing brick | Published literature: [5,9,19-26] |
|                 | External wall   | Plaster   | Catalogues: Orion Contract Sdn Bhd, Decasa Marbles Sdn Bhd. |
|                 |                 | Paint     |         |
|                 |                 | Tiles (i.e. marble, granite, porcelain, etc.) |         |
|                 |                 | Wallpaper |         |
|                 |                 | Wood wall panel |         |
| Ceiling         | Suspended ceiling | Plaster / skim coat | Published literatures: [5,9,17-20,23-24,26] |
| Roofing         | Flat roof       | Concrete  |         |
|                 | Pitched roof    | Metal     | Catalogues: Wira Sky Steel Sdn Bhd, Delux Skylight Roofing Sdn Bhd, Delux Structural Works Sdn Bhd, Monier Malaysia Sdn Bhd, Supercool Creative Culture Sdn Bhd, COD Marketing Sdn Bhd. |
|                 | Skylight & awning | PVC |         |
|                 |                  | Asbestos  |         |
|                 |                  | Wood      |         |
4.2. Phase II: Identification of factors influencing the LE of generic house components and LE of each component

Consequently, the identification of factors influencing LE of generic house component and LE of each component was also carried out through reviewing established materials based on the previous checklist developed in Phase I.

Based on the data collection process for influencing LE factors, 16 established sources were analysed. The findings shows that, there are eight (8) common factors, namely; (1) weather and climate condition, (2) design, (3) maintenance and replacement, (4) intensity of use, (5) quality of materials and products, (6) technological obsolescence, (7) workmanship, and (8) insects damage. Table 2 below shows those factors which were tied to house components and its sources.

Table 2. Generic house components in Malaysia

| Generic house components | Factors influencing the LE | Sources |
|--------------------------|----------------------------|---------|
| **Column & beam** | - Design | - Technological obsolescence | [5, 11, 13, 15, 17-18, 20, 22-23, 25, 28-29] |
| | - Insect damaged | - Weather & climate condition | |
| | - Maintenance & replacement | - Workmanship | |
| | - Quality of materials & products | | |
| **Staircase** | - Design | - Quality of materials & products | [5, 11, 13, 15, 17-18, 20, 22-23, 25, 28-29] |
| | - Usage & user activities | - Technological obsolescence | |
| | - Insect damaged | - Weather and climate condition | |
| | - Level of maintenance | - Workmanship | |
| **Door** | - Design | - Quality of materials & products | [5, 11, 12, 15, 17-18, 20, 22-23, 25, 28-29] |
| | - Intensity of use | - Technological obsolescence | |
| | - Insect damaged | - Weather and climate condition | |
| | - Level of maintenance | - Workmanship | |
| **Window** | - Design | - Quality of materials & products | [5, 11, 15, 17-18, 20, 22-25, 28-29] |
| | - Intensity of use | - Technological obsolescence | |
| | - Insect damaged | - Weather and climate condition | |
| | - Level of maintenance | - Workmanship | |
Meanwhile, the identification of LE for each generic house component was carried out similarly through MLTP process of five (5) established standards and guidelines comprised of Adena Certified Inspections (US) [20], Economics Group of NAHB (US) [11], International Associations of Certified Home Inspectors (US) [34], The Cascade Team Real Estate (US) [29], and British Columbia (Canada) [35]. Table 3 below shows the minimum, maximum, and average years of the LE towards house components and their materials.

Based on Table 3, it can be seen that generic house components which have minimum LE of below than ten years are vinyl material for roofing, toilet and bathrooms fitting and fixtures, as well as house finishing. Whereas, brick/concrete material for wall, column and beam has a lifetime of more than 100 years. In a nutshell, it can be concluded that the overall generic house components have different LE towards a different type of materials, which happened to be depending on the certain influencing factors.
Table 3. Life Expectancy (LE) of generic house components based on several sources

| House components | Summary LE (years) | Min. LE | Max. LE | Average |
|------------------|-------------------|---------|---------|---------|
| Column & beam    |                   |         |         |         |
| Concrete         | 10                | 100+    | 70      |         |
| Timber           | 10                | 100+    | 34      |         |
| Staircase        |                   |         |         |         |
| Concrete         | -                 | 100+    | 100+    |         |
| Timber           | 10                | 50      | 31      |         |
| Metal (e.g. copper, stainless steel, iron, etc.) | 15 | 100 | 33 |
| Glazing          | 10                | 40      | 23      |         |
| Door             |                   |         |         |         |
| Glazing          | 10+               | 20      | 17      |         |
| Vinyl (e.g. PVC, uPVC) – for shower | 20 | 50+ | 29 |
| Metal (e.g. aluminium, stainless steel, etc.) | 15 | 50+ | 28 |
| Fibreglass       | 10+               | 20      | 17      |         |
| Timber           | 15                | 100     | 44      |         |
| Window           |                   |         |         |         |
| Glazing          | 10+               | 20      | 22      |         |
| Vinyl (e.g. PVC, uPVC) – for shower | 20 | 40 | 28 |
| Metal (e.g. aluminium, stainless steel, etc.) | 15 | 50 | 27 |
| Timber           | 15                | 50      | 29      |         |
| Floor            |                   |         |         |         |
| Concrete         | 30                | 100+    | 72      |         |
| Timber           | 15                | 100+    | 45      |         |
| Wall             |                   |         |         |         |
| Brick/concrete   | -                 | 100+    | 100+    |         |
| Glazing          | 10+               | 20      | 17      |         |
| Timber           | 10                | 100+    | 43      |         |
| Ceiling          |                   |         |         |         |
| Gypsum board     | 30                | 75      | 58      |         |
| Timber           | 20                | 50      | 36      |         |
| Vinyl (e.g. PVC, uPVC) | 20 | 30 | 25 |
| Metal (e.g. aluminium, etc.) | 15 | 80 | 34 |
| Fibreglass       | 10+               | 20      | 14      |         |
| Roofing          |                   |         |         |         |
| Concrete         | 20                | 100+    | 73      |         |
| Metal (e.g. aluminium, zinc, etc.) | 15 | 100+ | 41 |
| Vinyl (e.g. PVC, uPVC) | 8 | 25 | 17 |
| Tiles (e.g. clay, etc.) | 20 | 100+ | 61 |
| Timber           | 15                | 30      | 27      |         |
| House fittings & fixtures | | | | |
| Toilet & bathrooms | 5 | 100+ | 25 |
| Kitchen          | 14                | 30      | 19      |         |
| Electrical       | 8                 | 40      | 43      |         |
| Common finishing for all house components | | | | |
| Indoor/Outdoor   | 5                 | 100+    | 34      |         |
| Ironmongery      | Metal (e.g. stainless steel, aluminium, etc.) | 15 | 50 | 28 |

Thus, from the overall findings, a list of the suggested range of LE which compatible to be used has been developed. It was being stratified into six (6) scales which are; (1) 0-10 years, (2) 11-20 years, (3) 21-30 years, (4) 31-40 years, (5) 41-50 years, and (6) 51 years and above [36]. The interval between scales are in 10 years, given the summary of LE from literature review indicated five years as a minimum value and 100 years as a maximum value. Thus, to compensate for the wide differences in range and to offer a meaningful representation, hence the interval. Last but not least, figure 2 shows the conceptual framework for the literature review results.
5. Conclusion
The paper set out to identify the factors influencing the LE of generic house components and their LE through literature review processes employing the qualitative MLTP. The findings found that in general there are various LE’s factors including weather and climate condition, design, maintenance and replacement, the intensity of use, quality of materials and products, technological obsolescence, workmanship, and insects damaged. One of the findings that emerged from this study is that every component has different LE depending on the influencing factors towards the LE. Apart from enhancing the related body of knowledge, the findings will serve as a basis for subsequent exploration of research on building maintenance’s realm.

Nevertheless, noted that the findings of the paper are subjected to a limitation in term of the type of house involved. The findings were not suitable to be applied for high-rise building, which comprises of mechanical elements such as lift, HVAC, and others since they are not being covered in the study. Therefore, as a recommendation, further research on overall building maintenance, including high-rise residential and the business building was applauded.

6. References
[1] Kariya N, Abas N H, Mohammad H and Yaman S K 2017 Conceptualising the Life Expectancy of House Components in Malaysia Int. Symposium on Civil and Environmental Engineering 2016 (Melaka) vol 103 (Paris: MATEC Web Conf.) 03017
[2] Mohammad H, Yaman S K, Hassan F and Ismail Z 2016 Determining the Technical Competencies of Construction Managers in the Malaysia’s Construction Industry The 3rd International Conference on Civil and Environmental Engineering for Sustainability (Melaka) vol 47 (Paris: MATEC Web Conf.) pp 1053–1059
[3] Lateef O A, Khamidi M F and Idrus 2010 A Building Maintenance Management in a Malaysian University Campus: A Case Study Australasian J. of Constr. Economics and Build. 10 76–89
[4] Akasah Z A, Abdul R M A and Zuraidi S N F 2011 Maintenance Management Success Factors for Heritage Building: A Framework 12th Int. Conf. on Structural Repairs and Maintenance of Heritage Architecture (Italy) vol 118 (UK: WIT Trans. on the Built Environ.) pp 653–658
[5] Alshehri A, Motawa I and Ogunlana S 2015 The Common Problems Facing the Building Maintenance Departments Int. J. of Innovation, Management and Technology 6 234-237
[6] Che-Ghani N Z, Myeda N E and Ali A S 2016 Operation and Maintenance Cost for Stratified Buildings: a Critical Review The 4th Int. Building Control Conf. 2016 (Kuala Lumpur) vol 66 (Paris: MATEC Web Conf.)

[7] Ch’ng B 2015 Emergency RM1.8mil Allocation to Repair Rusty Railings at Kota Damansara PPR Flats The Star Online, Malaysia (29 January 2015)

[8] Ch’ng B 2015 Five-year-old Falls to His Death from Sixth Floor The Star Online, Malaysia (29 January 2015)

[9] Construction Industry Development Board Malaysia 2014 CIS 7:2014 Quality assessment system for building construction works (Kuala Lumpur: CIDB)

[10] Lee K Q 1990 Building Maintenance & Modernisation Worldwide Proc. of the Int. Symposium on Property Maintenance Management and Modernisation (Singapore) (Singapore: Longman) pp 138–145

[11] Economics Group of NAHB 2007 Study of Life Expectancy of Home Components (United States of America: NAHB)

[12] Omar Bakri N N and Othuman Mydin M A 2014 General Building Defects: Causes, Symptoms and Remedial Work Eur. J. of Technology and Design 3 4–17

[13] Syed <alomad S B H and Wan Annuar W F H 2011 Engineering Approach System to Assess Defect and Deterioration of Building Structures Int. Seminar on the Application of Science & Mathematics (Kuala Lumpur) (Johor: UTHM)

[14] Creswell J W 2012 Educational research: Planning, conducting, and evaluating quantitative and qualitative research (United States of America: Person Education)

[15] Kariyani, Yaakob Z, Mohd Sairi M N, Mohammad H, Yaman S K and Abas N H 2016 Investigation of Generic House Components and Their Practical Ways to be Assessed by House Buyers during Defect Liability Period (DLP) in Malaysia Int. J. Eng. Trans. A-Basics 29 1354-1363

[16] Yaman S K, Abdullah A H, Mohammad H and Hassan F 2015 Technical Competency of Construction Manager in Malaysian Construction Industry Appl. Mech. Mater. 773–774 1053–1059

[17] Ashworth A 1996 Estimating the life expectancies of building components in life-cycle costing calculations Struct. Surv. 4 4–8

[18] Home Builders Association of Northwest Indiana 2015 How Long Will It Last? The Life Expectancy of Your Home’s Components Retrieved on January 19, 2016 from https://www.nwitimes.com/lifestyles/home-and-garden/hba-how-long-will-it-last-the-life-expectancy-of/article_2f4e9fdd-f70c-50d2-8395-ca300d3dc463.html

[19] Che-ANI A I, Zahrarim A, Mohd Zain M F, Mohd Tawil N and Surat M 2009 Timber Defects In Building: A Study of Telapak Naning, Malacca, Malaysia, WSEAS Trans. Environ. Dev. 5 no. 1 109–118

[20] Larson B 2016 Life Expectancy of a Home’s Components and Systems Retrieved on January 21, 2016 from https://www.adenacertifiedinspections.com/home-components-info/component-lifespan

[21] Abdul Rahman S and Agus Salim N A 2013 A Study on Defects Affecting Maintenance The 5th Undergraduate Maintenance and Facilities Maintenance Conference

[22] Ahzahar N, Karim N A, Hassan S H and Eman J 2011 A Study of Contribution Factors to Building Failures and Defects in Construction Industry Proc. Eng. 20 249–255

[23] Chew M Y L, Tan S S and Kang K H 2004 Building Maintainability-Review of State of the Art J. Archi. Eng. 10 80–87

[24] Syed Mohamad S B H, Akasah Z A and Rahman A 2014 Factors Contributing to Building Maintenance Performance of Heritage Buildings Proc. of the Int. Civil and Infrastructure Engineering Conference 2013 (Singapore: Springer Science + Business Media) pp. 978–981

[25] Rotimi F E, Tookey J and Rotimi J O 2015 Evaluating Defect Reporting in New Residential Buildings in New Zealand Buildings 5 39–55
[26] Ahmad Zamri N, Wan Alwi W A and Mat Hassan H S 2012 Kualiti Bahan Binaan Projek Perumahan; Kajian Kes Perumahan Iskandar Perdana, Seri Iskandar 1st Int. Conference on Innovation and Technology for Sustainable Built Environment 2012 (Perak) pp 825–833
[27] Wahab S N A and Hamid M Y 2011 A Review Factors Affecting Building Defects of Structural Steel Construction. Case Study : Student Accommodation in UiTM Perak Procedia Eng. 20 174–179
[28] Bagdiya N V and Wadalkar S 2015 Review Paper on Construction Defects, IOSR J. Mech. Civ. Eng. 12 88–91
[29] The Cascade Team Real Estate 2012 Remodeling Cost & Life Expectancy Guide (United States of America: Washington D.C.)
[30] The Building and Construction Authority Singapore 2014 The BCA Construction Quality Assessment System (CONQUAS) (Singapore: BCA)
[31] Suffian A 2013 Some Common Maintenance Problems and Building Defects: Our Experiences Procedia Eng. 54 101–108
[32] Buys F and Roux M 2013 Causes of Defects in the South African Housing Construction Industry: Perceptions of Built-environment Stakeholders J. Phys. Dev. Sci. 20 78–99
[33] Othuman Mydin M A, Agus Salim N A, Tawil S W and Ulang N M 2014 Assessment of Significant Causes to School Building Defects Emerging Technology for Sustainable Development Congress (ETSDC 2014) (Malaysia) vol 3 (E3S Web of Conf.) pp 1–7
[34] InterNACHI International Association of Certified Home Inspectors 2006 InterNACHI’S Estimated Life Expectancy Chart for Florida Homes Retrieved on December 04, 2015 from http://www.nachi.org/florida-life-expectancy.htm.
[35] Homeowner Protection Office 2014 Residential Construction for New Home Covered by Home Warranty Insurancein British Columbia (British Columbia: Homeowner Protection Office)
[36] Joseph F B and Marianne B 2011 Shedding new light on auditor switching: this article is based on a study supported by the IMA[R] foundation for applied research (FAR) (United States: Institute of Management Accountants) pp 49–53

Acknowledgments
The authors would like to convey sincere gratitude to Universiti Tun Hussein Onn Malaysia (UTHM) for sponsoring this research through their in-house research grant (STG U638).