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Framework in Developing Model of Interfloor Leakage in High-Rise Residential Buildings in Malaysia

Siti Rosemawar Mohd Sahi[a], Norngainy Mohd Tawil[a*] & Kuan You Wai[b]

[a]*Department of Architecture & Built Environment, Universiti Kebangsaan Malaysia, Malaysia*
[b]*PKN Building Solutions Sdn Bhd*

**Corresponding author: norngainy@ukm.edu.my*

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ABSTRACT

Interfloor leakage is amongst the highest claims reported to the Strata Management Tribunal. This defect affects strata communities directly and indirectly in cost of repair, occupant safety, health and disputes. Regulation 55 of the Strata Management (Management and Maintenance) Regulation 2015 under Strata Management Act 2013 defines interfloor leakage as any evidence of dampness, moisture or water penetration, and has underlined the work process of interfloor inspection. However, issues are investigating the cause of leakage and repair costs, and determining who is responsible for the repair. Conducting defect assessment by standards is the collection of systematic information to evaluate building performance, investigate defect elements and recommend appropriate repairs. The research concept framework examines the effect or influence of each construct on another construct. Constructs are three, namely, interfloor leakage management, legislation and owner satisfaction. Based on the literature review, the conceptual framework is produced, and each of these constructs is developed with several dimensions to be tested. The sequential exploratory design method is used with a combined approach of qualitative interviews and discussions with experts in the field of property management and building pathology to form a questionnaire for distribution to the management. This research is essential to decide how to reduce disputes, discuss the costs of repair and select a party to execute repairs that create quality strata management that benefits the owners, management and stakeholders

Keywords: Interfloor leakage; building defect; strata management; dispute; building condition assessment report

INTRODUCTION

Interfloor leakage is important to be reviewed because many complaints have been reported to the building management, the Commissioner of Building (COB) and *Kementerian Perumahan dan Kerajaan Tempatan* (KPKT). These frequent, recurring complaints have resulted in a section of Regulation 55 of the Strata Management (Management and Maintenance) Regulation 2015 (SMR) under Strata Management Act 2013 (Act 757) on interfloor leakage management using Form 28 effective 1 June 2015. It is a guidance to ensure that the responsible parties repair interfloor leakage according to the standard operating procedure (SOP) mentioned in the regulations.

Any unresolved complaint at the management level and COB are then taken to the Strata Management Tribunal (SMT). (EdgeProp.my 2018)**,** the SMT recorded 4,390 cases in 2017 to 2018 and claimed that the highest cases are overdue maintenance charge and interfloor leakage. (Chang Kim Loong 2015) agreed that interfloor leakage is often a problem in multistorey dwellings, resulting in more severe damage, higher costs and ultimately conflicts between owners and management due to lack of expertise to identify the cause of leaks and inaccurate repair recommendations.

Whilst the Strata Tribunal Board of Singapore (The Straits Time 2017) stated that at least 289 complaints were recorded, 188 were about interfloor leakage, the highest being in 2013 until 2014. It is equivalent to 65% of the cases in Singapore. That it is high time to review interfloor leakage issues is supported by last reviewed (Mohamad 2015), and interfloor leakage occurring in multistorey housing is 30.6% in Kuala Lumpur.

Ishak et al. (2009) discovered that interfloor leakage frequently occurs in toilet floor areas for multistorey dwellings in Malaysia due to dampness and water dripping to the floor below the unit. However, this study discussed the issue of leakage in general without investigating interfloor leakage issues in detail.

Interfloor leakage is one of the issues in defects, and the existence of the Housing Defect Act 1984 by the United Kingdom shows the seriousness of this problem that occurs throughout the country. In Malaysia, no defect act exists, but many guidelines are provided by government bodies to ensure the quality of construction such as Uniform Building by Laws (UBBL 1985).

Despite, preparing a systematic building condition assessment (BCA) report using a guideline is an effective way to ensure that the building inspection's visual and/or structure is conducted under Malaysian standards (Salim & Zahari 2011). This report needs to be in line with the *Garis Panduan Pemeriksaan dan Penilaian Keadaan Bangunan Sedia Ada Jabatan Kerja Raya* (Jabatan Kerja Raya 2013) (government building), RICS Building Survey Report (2005), BRE Design Quality Manual (2007), American Society for Testing and Materials Standard 2018 (ASTM E-2018) (2008), RICS Home Buyer Report (2009), Condition Survey Protocol (CSP) 1 Matrix (2010), RICS Condition Report (2010), and RISM Code of Practice for Building Inspection (CPBS101) (2011).

However, Che-Ani et al (2016) in their research found ASTM, RICS and BRE are not familiar standard or protocol developed as a guide for building inspections process. In accordance with the standards, BCA recording is intended to aid inspectors in their duty hence that the inspections will run smoothly, consistently, systematically and holistically by optimizing cost using sustainability approach (Khahro, 2021).

HIGH-RISE RESIDENTIAL BUILDING ISSUES

Based on an analysis recorded in 2019 (*Kementerian Perumahan dan Kerajaan Tempatan 2019*), as many as 8.7 million people live in high-rise residential buildings and land, with a total of approximately 2.1 million titles owned. The number of people and the titles held rise as the economy improves and the development of the country increases. Kuala Lumpur and Selangor dominate the highest strata titles owned in Malaysia, with Selangor holding 66% of strata development areas. The highest complaints are about maintenance and facility damage (*Kementerian Perumahan dan Kerajaan Tempatan 2018, 2019; Kementerian Perumahan dan Kerajaan Tempatan 2017*).

Such ownership faces various issues, such as overdue maintenance fees (Mohamad 2015; Tawil et al. 2012; EdgeProp.my 2018). This situation causes the management bodies' inability to finance the expenses needed for repairs of common properties and explains the mediocre quality of the services provided (Che-Ani et al. 2011; Grum 2017). Parking problems, pets and noise disturbance (Mohamad 2015; Cradduck 2013b; Easthope & Tice 2011; Mohamad & Sufian 2013) are common issues causing the strata residents to feel uncomfortable and can result in dissatisfaction amongst them.

The highest complaints are about maintenance and defects (*Kementerian Perumahan dan Kerajaan Tempatan 2018, 2019; Kementerian Perumahan dan Kerajaan Tempatan 2017*). The strata residence owners' most recorded complaints and issues in Laporan Tahunan COB PBT KPKT year 2019 are categorized and recorded, as shown in Figure 1 below.

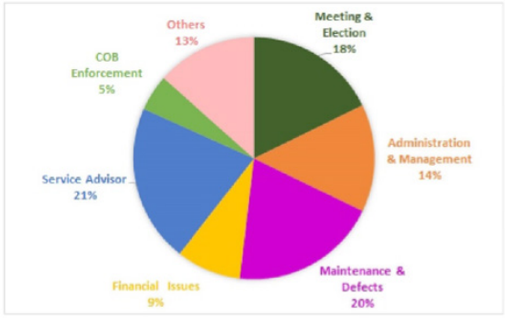

FIGURE 1. Number of Complaints Received in 2019
Source: Laporan Tahunan PBT 2019

Strata residential building management is a crucial element in a strata development scheme to enable well-supervised management and maintenance, which result in a harmonious living environment (Che-Ani et al. 2010; Cradduck 2013a). A harmonious living environment is essential to attract buyer or investor interest and increase market value (Christudason 2007, 2008).

Therefore, an owner or a buyer must possess relevant knowledge or information about strata residence management in terms of responsibility, rules and the living culture before owning a unit. This understanding matters more than lifestyle prospects (Cradduck 2013a; Mohamad & Sufian 2013). However, learning and awareness of the shared properties need tolerance and time because the rules on strata building management and maintenance were created only around the year 2007.

BUILDING DEFECT PHENOMENON

Building defects are common phenomena in the global construction industry. An ideal building to be handed to the client should be ultimately flawless. Multistorey building defects, such as cracked surfaces and leakages, are often caused by inefficient work by the consultants and labour workers, insufficient funds (Ali & Wen 2011; Forcada et al. 2014), low quality of construction materials (Ahzahar et al. 2011), and inadequate planning time and scheduling of work execution (Mohamad 2015; Christudason 2008; Ismail et al. 2012; Leshinsky & Mouat 2015; Rotimi et al. 2015).

The three causes of leakage (Kementerian Perumahan dan Kerajaan Tempatan n.d.) are humans; early failure during the designing process, lack of construction materials, shoddy quality work and no/less ongoing maintenance; building; domestic pipe leak/sewage pipes/floor, obsolete water pipes (wear and tear), cracks on building walls, damage/cracks on ceramic tiles, overflowing water tanks and design-expired bathroom flooring; and roof; damaged roof, damaged building gutters and damaged rain gutter pipe. Jabatan Kerja Raya defined building defect as the failure or the inability of a building to function correctly in terms of the building or user needs that involve structure, frame, fabric, service or building facility.

Shirkavand et al. (2016) identified poor workmanship during construction, poor design and incorrect installation as contributing factors to building defects. (Ahzahar et al. 2011; Ojo et al. 2014; Rotimi et al. 2015) reported that several factors contributing to building defects include poor workmanship, poor design (Talib et al. 2015) and low-quality materials. Forcada et al. (2013, 2014, and 2016) stated that poor workmanship affects functionality, and low-quality and unsuitable materials installed during construction contribute to building defects. The above studies indicate that the quality of work during construction, design problems and inferior quality materials are the top factors contributing to building defects.

Previous studies also suggested that measures to control the quality of construction must be considered by all construction parties. However, a study showed that the quality of construction is a problem with the building's defects, and management can hardly conduct effective maintenance if the same issue remains unresolved. This matter is discussed further throughout this research to explore other elements that contribute to building defects because many new buildings have been reported to be defective (Rotimi et al. 2015; Hopkin et al. 2016) during the defect liability period (DLP) (Hasim & Tabassi 2015; Plebankiewicz & Malara 2020).

In a nutshell, defect can be categorized into structural and nonstructural and into two types, namely, patent defect and latent defect (Bakri & Mydin 2014). Patent defects are those that become apparent during DLP and shall be rectified in accordance with the SOP stipulated in Housing Development (Control and Licensing) Acts 118 and 757. Latent defect are hidden defects that could not have been discovered by a reasonably thorough inspection.

They normally surface after DLP prior to the expiry of the typical service lifespan of the affected building components. Moreover, (Ishak et al. 2009) summarized in their research the causes of leakages according to rank as poor workmanship during construction fault, climate condition and design fault such as selection of material, detailing and supervision, as shown in Figure 2 analysis of leakage or defects.

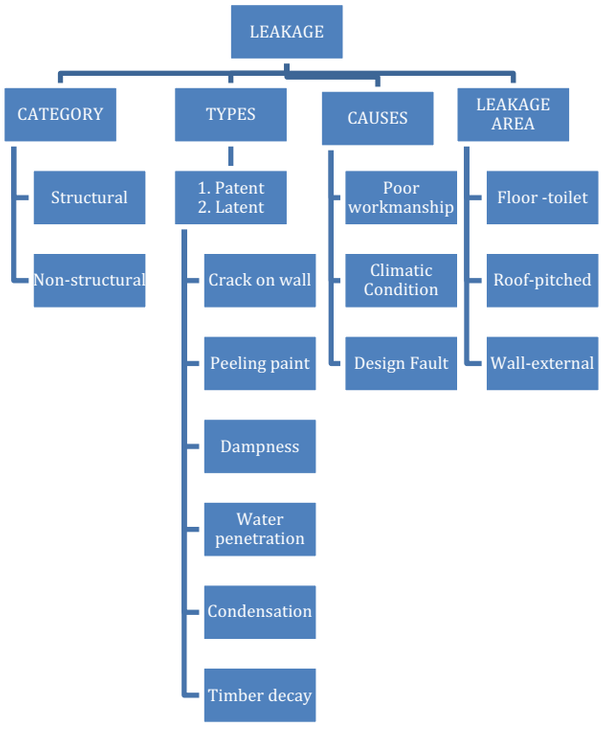

FIGURE 2. Analysis of leakage

INTERFLOOR LEAKAGE ISSUE AND METHOD OF TESTING

Interfloor leakage is one of the highest number of cases received by SMT in the years 2017 to 2018 as mentioned earlier. According to Ismail (2017), Meng and Kamaruzaman (2014), Nur et al. (2011), Talib et al. (2015b, 2015c) and Vilhena et al. (2010), moisture and cracked walls are the most recorded cases of building defects globally because of the weather, the type of construction materials used, and wear and tear. Forcada et al. (2016) proved that elements, such as inner walls (60%), windows (17%), and mechanical and electrical systems (9%), are often the parts that face these defects; doors, outer walls and rooftops comprise 5%. Previous case studies revealed that vacant spaces with the most defects are bedrooms, bathrooms and kitchens (Pan & Thomas 2013) because of low workmanship quality during construction (Forcada et al. 2014).

High humidity can cause cracks on walls and buildings, and instigate fungal growth. The SMR defines interfloor leakage as any dampness, moisture or water penetration in the ceiling, common property or limited common property along with the leakage in a strata title under Clause 55(1). Interfloor leakage's problem should be given attention because the topic is covered from Clause 55 to 64. Figure 3 show symptoms water leakage and dampness effect appearing due to leakage from the wet area above.

FIGURE 3. Dampness effect clearly be seen at this ceiling due to leakage from the wet area above

When a leakage occurs, water seeps into the concrete and calthemites form (Talib et al. 2015c; Talib et al. 2015d), as shown in Figure 4. Calthemite (Figure 5) is a calcium deposit formed from concrete, chalk, mortar and other dangerous chemicals found from the building's environment. It is white and forms stalactites from the top and stalagmites from the bottom surface of a man-made structure.

FIGURE 4. Leakage of toilet detected on the floor trap (down pipe)

FIGURE 5. Calthemite formed from concrete

The leak appears when the design of an item is expired, oxidized or worn off. It shrinks in size, and the strength and elasticity wear off. Testing is conducted by a specialist using test equipment to determine moisture and appropriate maintenance. Inspections consist of three categories: visual, destructive and nondestructive tests.

The nondestructive test aims to determine the leaking path by recreating the leak at localized spots or building components without performing hacking or demolition. The tasks' inspection tools include a moisture meter (Figure 6) used to detect moisture content in materials and an infrared thermography camera (Figure 7) used to measure temperature variances of a component as heat flows through, detection of leaks, thermal bridge and structural defect.

FIGURE 6. Moisture meter

FIGURE 7. Infrared thermography camera

Flood tests are commonly used to verify the waterproofing integrity of toilets, balconies and small concrete flat roofs. The drain holes are blocked, and the toilet is flooded with water level not exceeding four inches of height. However, chaos occurs in the way of blocking the floor traps. In several cases, the odd shape of the floor trap disallows the use of standard pipe blockers.

The standard diagram of internal waterproofing practice in flood testing by blocking the waste pipe instead of the floor trap cover with the intention of the porous cement screed and the waterproofing membranes can be subjected to increase in hydrostatic pressure. Figure 8 shows waterproofing details at a floor trap, whereas Figure 9 shows waterproofing detail upturn at walls. The waterproofing membrane is dressed up at pipe penetration to the finished floor level and dressed down into the floor outlet. The membrane is applied horizontally around the pipe, and the coating overlaps with the subsequent membrane applied to the entire wet area.

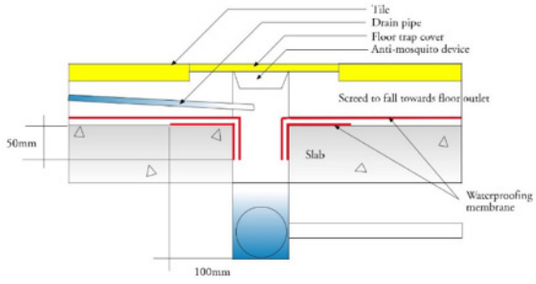

FIGURE 8. Waterproofing details at floor trap

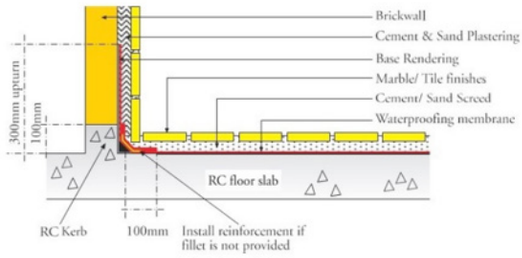

FIGURE 9. Waterproofing detail upturn at walls

Another nondestructive test to determine leaking is pressure gauge testing. The testing method is used to verify the water tightness of domestic water pipes. Adjusted electronic water pressure gauge chilled water a data logger used to record the variations in water pressure thoroughly and explicitly. Figure 10 shows an electronic pressure gauge testing according to the Guideline Repair Work and Testing by *Suruhajaya Perkhidmatan Air dan Tenaga*.

FIGURE 10. Pressure pump to test water pressure

A refined, constructed wet area can provide exceptional water tightness whilst attaining other performance obligations, including visual, air quality, thermal, integrity and space. The UBBL 1984 was published to ensure the uniformity and quality in various industries, especially construction. However, several construction works in Malaysia violate the codes, thus producing low-quality work and dissatisfaction with the construction product.

The National Housing Policy 2011, through Thrust 2 (Improving the Quality and Productivity of Housing Construction), outlined measures by government agencies and the private sector involved to improve the quality and productivity of housing construction. The Construction Industry Standard (CIS 7:2006) developed by the Technical Committee on Quality Assessment in Construction (QLASSIC) has been made mandatory and is being applied throughout Malaysia.

This element guide is vital for the pre inspection of buildings before the VP hands it to the buyer. In addition to QLASSIC, Malaysia needs awareness in terms of complying with building inspection standards and protocols, such as the RICS Building Survey Report, ASTME-2018 and CPBS101.

BUILDING CONDITION ASSESSMENT

Visual inspection is implemented to determine the performance of buildings (Abdul-Rahman et al. 2014; Grum 2017; Rotimi et al. 2011; Zuraidi et al. 2020). This method is a systematic process to obtain data, anticipate repairs and make updates or replacements that can preserve an elements capabilities. BCA is also essential for building management to make vital repair or replacement decisions and achieve maintenance goals in accordance with service standards (Yacob et al. 2019). KPKT, Kuala Lumpur City Hall (DBKL) and Kajang Municipal Council (MPKj) currently issued guidelines for preparing BCA reports for periodic building inspections based on visual or full-structure investigation (as required).

The following legislation found that a party with expertise should prepare a building condition report under Section 85(a), Street, Drainage and Building Act 1974 Act 133 (Amendment until 10 March 2020) - Periodic Inspection of Buildings and Slopes; Clause 52 (1), SMR - Appointment of a registered architect, registered engineer, registered material surveyor or registered building surveyor for joint property damage investigation; Clause 64 SMR - The COB may appoint a registered architect, registered engineer, registered material surveyor or registered building surveyor to conduct interfloor leakage investigations; and Clause 43 (1), SMT - Tribunal Expert Report.

However, the study found that these guidelines do not have instructions on how inspections must be conducted in accordance with building inspection protocols. Accordingly, the COB must obtain the BCA report of the leak from an expert. The BCA report should also be implemented at the SMT level to facilitate the tribunal president's decision. To date, no guidelines for reporting the BCA are available to determine interfloor leakage according to the standards. Therefore, this study is essential to formulate a model to form a BCA reporting framework as clear BCA Report guidelines by Jabatan Kerja Raya., 2013, RICS Building Survey Report, ASTME-2018 and CPBS101 and may help assess the level of damage through several technical tests and determine the cause of leakage. The report is critical as a study in New Zealand (Rotimi et al. 2015) showed that new homes less than two years old are disabled; the survey also showed that 70% of the respondents need a building inspection report.

Building damage can be avoided by preliminary inspection (Malay Mail 2013), which is the responsibility of the stratified building management either during the management of the developer, JMB or MC under Act 757, namely, Sections 21 (1) (e), 50(3) (d) and 59(1) (e) to conduct periodic inspections of buildings with five stories and above and age of 10 years and up. In Penang, (Malay Mail 2013), reported that 349 multistorey buildings were given periodic building inspection notices, but local authorities received only 55 reports. Only 16% complied with the authorities' notice, indicating that awareness on this matter remains low, or the enforcement is not firm.

CONCEPTUAL FRAMEWORK

The purpose of this research is to construct a model to form a building condition report in accordance with the standards Jabatan Kerja Raya 2013, RICS Building Survey Report, ASTME-2018 and CPBS101., focusing on interfloor leakage in high-rise residential buildings. The objectives of this research are as follows: (1) explore the elements of frequent interfloor leakage and its causes; (2) identify the issues and problems faced by the management team, title owners, the TPS and the COB in giving decisions to responsible parties in terms of handling interfloor problems and (3) create a standardized report layout of the interfloor leakage issue in high-rise residential buildings.

The research questions concern why high-rise residential buildings experience interfloor leakage, how management teams conduct investigations and rule out the parties responsible for the interfloor leakage problem and how a standardised interfloor leakage report is made. The research concept framework displays the effect or influence of each construct on another construct. Thus, the three constructs are interfloor leakage management, legislation and owner satisfaction.

Based on the literature review that has been described from all the above topics (Table 1), this conceptual framework is produced and each construct is developed with several dimensions for testing which is the inter-floor leakage management, the dimensions emphasized were expertise, cost, reporting, and other elements obtained through the interview sessions represented by elements X1 and X2.

While for legal construction, the dimensions emphasized are warranty period, guidelines, latent defects and other elements obtained through interview sessions represented by elements Y1 and Y2. Moreover, for the satisfaction of the owners, the reviewer focused on harmony, safety, health and some other elements obtained through the interview sessions represented by the elements Z1, Z2 and Z3 as shown in Figure 10.

TABLE 1. Construct proposed in the literature

Constructs	Related Constructs
Inter-floor leakage Management	Optimizing cost and sustainability approach (Kahro, 2020) , building inspection report (Rotimi et al. 2015)
Legislation	Legal disputes (Mohamad 2015), defect during DLP (Hasim, & Tabassi 2015; Plebankiewicz & Malara, 2020), patent defect and latent defect (Bakri & Mydin 2014)
Owner Satisfaction	Harmonious living (Che-Ani et al. 2010; Cradduck 2013a), shared responsibility, life and health (Mohamad, M. & Hussein, S.M. 2018)

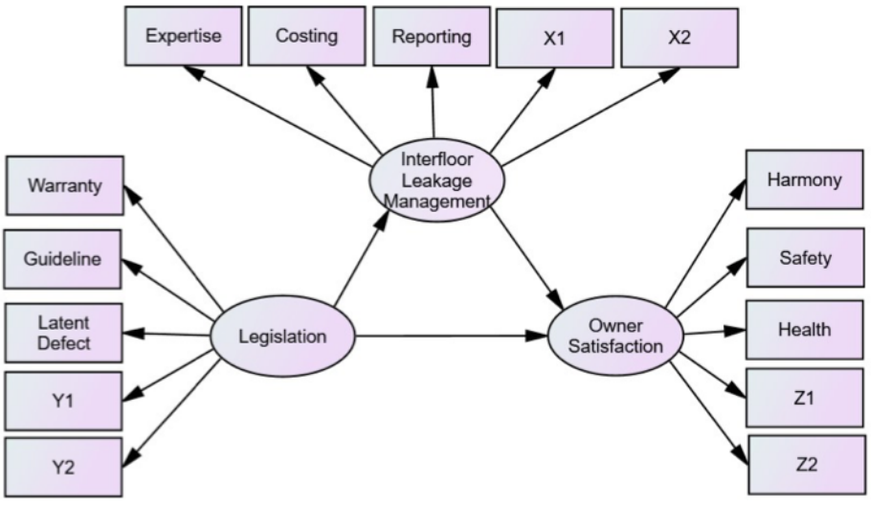

FIGURE 10.Conceptual Framework of the Research

RESEARCH SIGNIFICANCE

Findings from this research will benefit several parties. The owner can reduce the risk in terms of repair costs, obtain expert services and ensure their health and safety from dangers, such as fungal growth (Abdul-Rahman et al. 2014; Bakri & Mydin 2014; Othman et al. 2015). Pore reproduction is a green fungus that pollutes the air in the building and is harmful to the human respiratory system. In addition, the study can increase the satisfaction of living in a stratified residence (Grum 2017) when interfloor leakage and other defects can be managed efficiently. Management or JMB/MC obtains services from those who have the expertise and help control expenses when building defects are detected early (Fauzi et al. 2011). In addition, the trend of adopting Building Information Modelling (BIM) at the initial design stage proved beneficial for construction projects. The integration of BIM concepts into a design can effectively overcome the energy used in buildings and may affect sustainable management (Khahro 2021).

For local authorities, this research increases the integrity of the building (Che-Ani et al. 2016) to ensure the safety of occupants and the public, ensure that owners comply with the law and can increase the revenue of assessment rate collection. This study also helps the SMT and COB in terms of making efficient decisions and reducing disputes (Christudason 2008), thereby leveraging expertise in existing industries. More experts can be formed, and awareness of strata buildings' harmony and safety is increased (Mohamad 2015; Rotimi et al. 2011). Academically, this study provides additional scientific reference to future researchers.

RESEARCH METHODOLOGY

The researcher will study subjects, such as the sequential exploratory design, which uses a combined research method qualitative and quantitative approaches including Structural Equation Modeling (SEM). This method is suitable for research that requires exploration of elements to be used as survey instruments and fulfil the needs of study query.

According to the surveys, this combination method is conducted in two phases of the research: qualitative and quantitative data collection. In this study, the researcher collects qualitative data by conducting interviews and quantitative data by creating questionnaires.

The results of the qualitative research, which include review of the literature and consideration of experts' comments, are used to develop a survey questionnaire to collect the quantitative data from respondents (i.e. the quantitative analysis phase). Specifically, based on the literature review, a preliminary questionnaire is developed. Next, a pilot test is carried out to gather experts' comments to modify the questionnaire's characteristics, such as the clarity and adequacy of the items (i.e. failure factors) and criteria for measuring interfloor leakage, measurement scales and structure of the questionnaire.

After reaching a high agreement from experts, a complete questionnaire is finalized and used to collect the quantitative data. Then, in the quantitative phase, the factor analysis method is used to discover the failure factors of interfloor leakage and the interfloor leakage management construct, and the SEM technique is employed to develop and validate the model for examining the relationships between the failure factors of interfloor leakage and the interfloor leakage management construct. Finally, the findings of the study and their practical implications are discussed.

CONCLUSION

Factors listed in previous studies indicate that the quality of work during construction, design problems and inferior quality materials are the most discussed factors of defects. Therefore, carrying out effective maintenance is difficult for management if the same issue remains unresolved. In other study suggest collaboration between architects and structural experts is essential during planning (Teddy et al. 2018), in his study earthquake resistance planning. Hence collaboration among experienced management and maintenance is also seen as important.

This research discusses the type of leakage and the cause and area of the leakage to benefit academics, building owners and the maintenance team by identifying symptoms and determine the path of leakage using nondestructive testing and inspection. No disassembly or hacking is performed when testing using multiple testing tools and methods such as infrared thermography imaging, moisture meter, flood tests and electronic pressure gauge testing. Findings from this research will benefit several parties:

The owner can reduce the risk in terms of repair costs, obtain expert services and protect health and safety from the threat of dangers such as fungal growth, which can cause serious health problems to the occupants. Pore reproduction is a green fungus that causes the air in the building to be polluted and is harmful to the human respiratory system. In addition, the research can increase the satisfaction of living in a stratified residence when interfloor leakage and other defects can be managed efficiently.

The management will obtain services from experts and help control expenses when making early detection of building defects. For LA, this research will increase the integrity of the building to ensure the safety of occupants and the public, ensure owners comply with the law and can increase the revenue of assessment rate collection. This research will also help the SMT and building commissioners make efficient decisions and reduce disputes. More experts can be formed and increase awareness of strata buildings' harmony and safety. This research also contributes to the academic aspect that will add a source of scientific reference to future researchers.

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DECLARATION OF COMPETING INTEREST

None

REFERENCES

Abdul-Rahman, H., Wang, C., Wood, L.C. & Khoo, Y.M. 2014. Defects in affordable housing projects in Klang Valley, Malaysia. *Journal of Performance of Constructed Facilities 28*(2): 272–285.

Ahzahar, N., Karim, N.A., Hassan, S.H. & Eman, J. 2011. A study of contribution factors to building failures and defects in construction industry. *Procedia Engineering 20*: 249–255. http://dx.doi.org/10.1016/j.proeng.2011.11.162.

Ali, A.S. & Wen, K. 2011. Building defects: Possible solution for poor construction workmanship. *Journal of Building Performancernal 2*(1): 39–76.

Bakri, N.N.O. & Mydin, M.A.O. 2014. General building defects: Causes, symptoms and remedial work. *European Journal of Technology and Design 3*(1): 4–17.

Chang Kim Loong. 2015. Rectifying a leak in strata living. *The Star Online*, 26 September: 1–5. Malaysia. http://www.thestar.com.my/business/business-news/2015/09/26/rectifying-a-leak-in-strata-living/.

Che-Ani, A. I., Sairi, A., Johar, S., Abd Razak, M. Z., & Tawil, N. M. 2016. The practice of building inspection in Malaysian total asset management. *Jurnal Teknologi 78*(1).

Che-Ani, A. I., Mustafa, N. K. F., Tahir, M. M., Tawil, N. M., & Ramly, A. 2011. Kajian rintis terhadap konsep kualiti perkhidmatan dalam membentuk model teori keberkesanan pengurusan fasiliti perumahan bertingkat di Malaysia. *Research Journal 57*.

Che-Ani, A.I., Tawil, N.M., Sairi, A., Abdullah, N.A.G., Tahir, M.M. & Surat, M. 2010. Facility management indicators for high-rise residential property in Malaysia. *WSEAS Transactions on Environment and Development 6*(4): 267–276.

Christudason, A. 2007. Defects in common property of strata developments in Singapore: Representative actions against developers. *Structural Survey 25*(3–4): 306–318.

Christudason, A. 2008. Legislation affecting common property management in Singapore: Confusion or solution through fragmentation? *Property Management 26*(3): 207–219.

CPBS101: Code of Practise for Building Inspection Reports. Building Surveying Divison. The Institution of Surveyors Malaysia.

Cradduck, L. 2013a. Living a managed community lifestyle: Managed community lifestyle from Queensland. *Property Management 31*(4): 326–334.

Cradduck, L.M. 2013b. Parking, Parties and Pets : Disputes – the Dark Side of Community Living Dr Lucy Cradduck Faculty of Law , Queensland University of Technology. *19th Annual Pacific-Rim Real Estate Society Conference* (January): 13–16. http://eprints.qut.edu.au/56644.

Easthope, H. & Tice, A. 2011. Children in apartments: Implications for the compact city. *Urban Policy and Research 29*(4): 415–434.

EdgeProp.my. 2018. Maintenance fees and inter-floor leakage top cases in Strata Management Tribunal. *The Edge Market*, 12 July: 1–8. Malaysia. https://www.theedgemarkets.com/.

Fauzi, S., Yusof, N. & Abidin, N. 2011. Evaluation of Housing Defects in Build-Then-Sell Houses: A Study of Six Residential Areas. *World Academy of Science, Engineering and Technology 5*(10): 554–560. http://www.waset.ac.nz/journals/waset/v58/v58-113.pdf.

Forcada, N., Macarulla, M., Gangolells, M. & Casals, M. 2016. Handover defects: Comparison of construction and post-handover housing defects. *Building Research and Information 44*(3): 279–288.

Forcada, N., MacArulla, M., Gangolells, M. & Casals, M. 2014. Assessment of construction defects in residential buildings in Spain. *Building Research and Information 42*(5): 629–640.

Forcada, N., Macarulla, M., & Love, P. E. (2013). Assessment of residential defects at post-handover. *Journal of construction engineering and management 139*(4): 372-378.

Grum, B.B. 2017. Impact of facilities maintenance on user satisfaction. *Facilities 35*(7–8): 405–421.

Hasim, N. C., & Tabassi, A. A. 2015. The occurrence of building defects during defect liability period (DLP). *Jurnal Teknologi 75*(5).

Housing Development (Control and Licensing) 1966 (Act 118). International Law Book Services

Hopkin, T., Lu, S.L., Rogers, P. & Sexton, M. 2016. Detecting defects in the UK new-build housing sector: A learning perspective. *Construction Management and Economics* 34(1): 35–45.

Ishak, N. H., Che'Ani, A. I., Omar, Y., & Ramly, A. 2009. Identification of leakage syndrome towards the sustainability of residential buildings In Malaysia. International Engineering Convention, Damascus, Syria, 11-14 May 2009

Ismail, I., Tawil, N.M. & Yahaya, H. 2012. Housing Defect of Newly Completed House : An Analysis Using Condition Survey Protocol 620–623.

Ismail, N., Ali, S.N.A.M., Othman, N.A.A. & Jaffar, N. 2017. Occupants' satisfaction on building maintenance of government quarters. *AIP Conference Proceedings 1891*

Jabatan Kerja Raya. 2013. Garis Panduan Pemeriksaaan dan Penilaian Keadaan Bangunan Sedia Ada (JKR 21602-0004-13).

Kementerian Perumahan dan Kerajaan Tempatan. (t.th.). Phamplet Kebocoran Antara Tingkat dan Langkah Mengatasi

Kementerian Perumahan dan Kerajaan Tempatan. 2017. Laporan Tahunan COB PBT 2017.

Kementerian Perumahan dan Kerajaan Tempatan. 2018. Laporan Tahunan COB PBT 2018.

Kementerian Perumahan dan Kerajaan Tempatan. 2019. Laporan Tahunan COB PBT 2019. http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf.

Khahro, S. H., Kumar, D., Siddiqui, F. H., Ali, T. H., Raza, M. S., & Khoso, A. R. 2021. Optimizing energy use, cost and carbon emission through building information modelling and a sustainability approach: A case-study of a hospital building. *Sustainability 13*(7): 3675.

Leshinsky, R. & Mouat, C.M. 2015. Towards better recognising 'community' in multi-owned property law and living. *International Journal of Housing Markets and Analysis 8*(4): 484–501.

Malay Mail. 2013. New buildings could also have structural defects '. *Malay Mail,* 25 July 2013.Malaysia https://www.malaymail.com/.

Meng, L.S. & S.N Kamaruzaman. 2014. Assessment of High-Rise Residential Building's Quality In Handover Vacant Possession Process (Kuala Lumpur). *The Malaysian Surveyor 49*(2): 15–24.

Mohamad, N. A. 2015. An Exploratory Study of Strata Residential Properties Problems in Peninsular Malaysia and How They are Resolved. *Journal of the Korean housing association 26*(6): 53-60.

Mohamad, N. A. & Azlinor Sufian. 2013. Development on management of strata disputes in peninsular Malaysia : the way forward *1965*(March): 221–233. www.irmbrjournal.com.

Nur, S., Mohd, F., Yusof, N.A. & Abidin, N.Z. 2011. Common Defects Found in Build-Then-Sell Houses. *3*(4): 494–497. http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=69735407.

Ojo, A.M. and Ijatuyi, O.O. 2014. Defective construction in residential buildings: A study of Sunshine Gardens, Akure Nigeria. *International Journal of Civil Engineering, Construction and Estate Management 1*(2): 16–30.

Othman, N.L., Jaafar, M., Harun, W.M.W. & Ibrahim, F. 2015. A Case Study on Moisture Problems and Building Defects. *Procedia - Social and Behavioral Sciences 170*: 27–36. http://dx.doi.org/10.1016/j.sbspro.2015.01.011.

Pan, W. & Thomas, R. 2013. Defects of New-Build Dwellings Constructed to Building, Regulations And to The "Code For Sustainable Homes." *Procs 29th Annual ARCOM Conference (pp. 2-4)*. hlm. 1015–1025

Plebankiewicz, E. & Jarosław Malara. 2020. Analysis of Defects in Residential Buildings Reported during the Warranty Period. *Applied Sciences 5*(1): 39–55.

Rotimi, F.E., Tookey, J., Craig, N., Olabode, J. & Rotimi, B. 2011. Opportunities for defect reporting in new residential buildings: A case for New Zealand. *Association of Researchers in Construction Management, ARCOM 2011 - Proceedings of the 27th Annual Conference 2*(September): 643–652.

Rotimi, F.E., Tookey, J. & Rotimi, J.O. 2015. Evaluating defect reporting in new residential buildings in New Zealand. *Buildings 5*(1): 39–55.

Salim, N. A. A., & Zahari, N. F. (2011). Developing integrated building indicator system (IBIS)(a method of formulating the building condition rating). *Procedia Engineering*, *20*, 256-261.

Strata Management Act 2013. Percetakan Nasional Malaysia Berhad

Strata Management (Maintenance and Management) Regulations 2015 .Percetakan Nasional Malaysia Berha

Strata Management (Strata Management Tribunal) Regulations 2015. Percetakan Nasional Malaysia Berhad.

Street, Drainage and Building Act 1974 (Act 133). As at 10th March 2020. International Law Book Services

Talib, R., Ahmad, A. & Sulieman, M. 2015a. Building Design Failure. Why Did It Fail? How It Could have been Avoided? *International Journal of Chemical, Environmental & Biological Sciences (3*(5): 372–378. http://www.isaet.org/images/extraimages/P815220.pdf.

Talib, R., Ahmad, A.G. & Sulieman, M.Z. 2015b. Factor effecting typical interior defects (water based) found in Malaysian buildings. With real selected case samples. *International Journal of Emerging Trends in Engineering Research 3*(8): 55–64.

Talib, R., Ahmad, A.G. & Sulieman, M.Z. 2015c. Practical building defect solutions; construction failures to be avoidedReal case studies selected from Malaysian buildings. *International Journal of Emerging Trends in Engineering Research 3*(7): 44–49. http://www.warse.org/ijeter/static/pdf/file/ijeter01372015.pdf.

Talib, R., Boyd, D., Hayhow, S., Ahmad, A.G. & Sulieman, M. 2015d. Investigating Effective Waterproofing Materials in Preventing Roof Leaking; Initial Comparative Study: Malaysia, U.K. *Procedia Manufacturing 2*(February): 419–427. http://dx.doi.org/10.1016/j.promfg.2015.07.074.

Tawil, N. M., Yusoff, Y. M., Che-Ani, A. I., Abdullah, N. A. G., & Surat, M. (2012). A study of Management Corporation financial in high rise residential with correlation of management fund and facilities provided. *International Business Management*, *6*(3), 304-307.

Teddy, L., Hardiman, G., Nuroji, N., & Tudjono, S. (2018). The soft story challenge to architectural design in earthquake-prone areas. *Jurnal Kejuruteraan*, *30*(2), 141-151.

The National Housing Policy 2011 (2018-2025). "Rumah Berkualiti Harapan Rakyat'. Jabatan Perumahan Negara. Kementerian Perumahan dan Kerajaan Tempatan.

The Straits Times. 2017. Water Leakage A Big Issue Among Homes. *The Straits Times*, 11 May: 1–6. Singapore. https://www.straitstimes.com/singapore

Uniform Building By Laws 1984 (UBBL 1984).

Vilhena, A., Pedro, J.B. & Paiva, J.V. 2010. Assessment method for buildings' rehabilitation needs. Development and application. *2010 CIB World Congress - Building a better world*

Yacob, S., Ali, A.S. & Au-Yong, C.P. 2019. Establishing Relationship Between Factors Affecting Building Defects and Building Condition. *Journal of Surveying, Construction & Property 10*(1): 31–41.

Zuraidi, S. N. F., Rahman, M. A. A., & Akasah, Z. A. 2020. Condition Assessment of Heritage Building: A Case Study In Kota Bharu Kelantan, Malaysia. *Malaysian Construction Research Journal (MCRJ)*,