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Understanding the Common Defects in Commercial Buildings: Types, Causes and Remedial Actions

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ABSTRACT

Commercial building maintenance management constitutes a pertinent issue of global concern for all related stakeholders. In Malaysia, the management of commercial building maintenance plays a crucial role in achieving the goal of providing safety to occupants and the building itself. However, there is a paucity of studies that have comprehensively explored all dimensions of commercial building defects in relation to maintenance management. This research was also conducted to identify and analyze the typical defects that occur in commercial structures, understand their underlying causes, assess their impact on safety, functionality and propose effective remedial actions. The study utilized a qualitative approach for data collection. The findings indicated that cracked floors, floor tile failures, wall tiles failure, damaged ceiling, paint peeling and faulty light bulbs were some of the flaws that degrade commercial building. The study's outcome revealed that defects not only deface the aesthetic appearance of the commercial buildings but also inhibit the functionality of the buildings and depreciate the overall satisfaction. The research limitations include using commercial buildings (shopping complexes or malls) that have been operating for more than 20 years. This study offers invaluable insights for maintenance organizations and maintenance department staff who are genuinely interested in improving commercial buildings' maintenance management to optimize staff's performance and enhance the user satisfaction of the buildings in Malaysia and globally.

1. Introduction

Commercial buildings are more than just physical structures, they are the dynamic centres of urban landscapes, supporting vibrant communities and thriving economies. These structures, which range in size from little stores to towering skyscrapers, hold the various activities that make up our daily lives. Commercial buildings are fundamentally the physical representations of economic life. The growth in their building frequently reflects a strong local economy, whereas closings and vacancies may indicate changes in the direction of the economy. Beyond this economic gauge, these structures provide a platform for creative architectural design and a reflection of the dynamic character of our cities. Rapid economic development led to many constructions of commercial

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buildings with various unique and interesting designs. Kuala Lumpur, Penang and Selangor are the cities with the most commercial buildings in Malaysia. The commercial building is now being driven by cutting- edge new technology. Commercial buildings evolve as technological advances change how we work and communicate, turning them into centres of creativity and connectivity. The commercial landscape is a living example of how technology is incorporated into our daily lives, from smart offices that anticipate our requirements to retail spaces that seamlessly mix online and offline interactions.

However, commercial buildings will also have defects. Different types of defects will remain in place on each type of building built. It can depend on how the building is managed to mitigate or overcome the problems that occur in the building. Usually, commercial buildings have their own management to manage and maintain the building. There are several building defects that usually occur in different parts such as building roofs, walls, floors, toilet, windows and doors [1]. Building defects, if not dealt with quickly and efficiently will have a wide range of negative impacts on safety, finance and economic activities carried out in the commercial building. Customers who are in the building will feel unsafe and uncomfortable if they find that many defects are not maintained by the building management. It will affect economic activity when customers no longer want to come because they are worried about safety. Defects that are not maintained quickly and properly will cost a lot if left unattended for a long time as they will get worse.

The term of "defect" in the construction industry refers to inadequacies in the planning, design and construction processes and other external factors such as wear and tear [2]. Building defect is divided into two which is structural and non-structural defects. Jamal, (2017) [3] said that common types of structural defects that happen in building construction are cracks in foundation, floor and slab and in the wall. According to Hong, (2016) [4] the three main causes of defects that are often discovered during the defect's liability period are low-quality building materials, poor workmanship and faulty design. All these defects can happen due to poor workmanship, low quality materials, improper construction techniques, unsystematic maintenance management and climate. According to Blay *et al.,* (2019) [5], dampness in buildings affects the health of occupants, structural stability and energy efficiency of buildings.

Bad maintenance can also occur because of knowledge lackness and expertise on maintenance aspects. Therefore, the repair approach for the area is not so good that results in the problems to recur because maintenance group were dominated by those with mechanical and electrical background with limited knowledge on civil and structural aspects [6]. Poor and improper building maintenance will definitely cause more damage and costly repair works if left unattended. Secondly, according to Hauashdh *et al.,* (2020) [7], the rapid increment of building maintenance issues is currently having a severe effect on building maintenance success. Building maintenance is needed to keep a structure in good condition and functioning properly. Spending money on fixing a minor issue is way cheaper than spending on major issues. Nizam *et al.,* (2010) [8] noted that low-quality maintenance is still an issue and is contributing to a number of other issues, including defective building and inadequate building functionality because people are unaware of the high standards of care, that buildings need. Khalid *et al.,* (2019) [9] says that cost reduction, improved effectiveness and efficiency in maintenance works, increasing safety and well-being of the occupants, expanding the life of building stocks are also benefits of building maintenance. Effective maintenance planning is necessary to implement stable utility techniques for building structure.

This study is important because it helps to raise the awareness of the management, developer and parties related, to build an environment on the importance of maintenance practice to prevent building defects especially in Malaysia. Therefore, this study focused on the analyses of the current condition of building defects, in commercial building in northern Malaysia.

2. Literature Review

2.1 Commercial Buildings

Commercial buildings are structures specifically designed and constructed for commercial or business purposes and these buildings are intended to house businesses, offices, retail spaces or other commercial activities. Arunachelam, (2019) [10] noted an alternative definition of a commercial building is a structure that is not used for residential or civic functions. Office buildings, retail centres, hotels, restaurants, warehouses and mixed-use developments, which incorporate several economic operations in one location, are a few examples of commercial structures. Various retailers and other businesses lease space in commercial buildings in order to operate without buying a property.

Commercial buildings are designed to be easily accessible to customers, clients and employees, often complying with disability regulations to ensure inclusivity. According to Philip & Wan (2001) [11], utilities account for 25 % of a typical commercial building's operational expenditures, followed by repairs and maintenance (23 %), cleaning (17 %) and administrative work (17 %). Goh and Yuting, (2016) [12] stated that commercial buildings consume operation management costs higher compared to other types of buildings such as residential, industrial and institution buildings. According to a study by [13] in Nigeria, building services that do not operate properly due to inadequate maintenance procedures are from high-rise commercial buildings which is over 20 years old. This proves maintenance deficiencies in commercial high- rise building will increase maintenance costs and reduce profits.

2.2 Building Defects

Building defects are also defined as improper conditions that may cause impact to the building structure, leading to low quality and performance of the building. Building defect can occur during the construction process or after the completion of the building. Usually, the method of identifying building defects is through inspection, appropriate remediation measures and diagnosis of the underlying causes. Legal considerations can also come into play, especially if the defect leads to a dispute between the property owner, developer, contractor or other stakeholders.

According to Sufian (2013) [6] building defect will cause more damages and costly repair works if left unattended. Sufian (2013) [6] also pointed out in their study that the habit of defecting is waterproofing issue (leakage), crack, soil settlement and wall finishes problem. If the building defect is not addressed, it will affect the owners and users of the building. In other words, it will affect the functioning of the building as well as the building's performance.

Ali Hauashdh *et al.,* (2020) [7] says that building defects can shorten the life of the building. It will affect health and the safety of the buildings occupants. Building defect also prevent the buildings from performing their functions well and repairing building defects generates waste. This show the importance of preventing building defects is crucial for ensuring safety, functionality of structure and long-term durability.

2.3 Causes of Building Defects

Honeycombs, hairline cracks at beams, faulty design, construction materials, structural cracks in the walls, reinforcement bars of columns becoming rusty due to expose to sunlight and rainwater, etc. are some examples of the causes of the building defects. From the survey conducted by [2] in government hospitals, over 60 % from 337 survey conducted among doctors, they rated poor

maintenance practices and procedures is one of the reasons for building defect. Talib *et al.,* (2024) [14] noted that building defects happen due to lack of maintenance planning, lack of proactive maintenance plan and lack of proper implementation. Environmental factors can also contribute to building defects. Extreme weather conditions like earthquakes and floods can affect the building structure if the building is not designed to withstand such weather. Buildings can also be damaged when exposed to sunlight and even rain. This will cause the building to suffer from defects such as leaks and peeling of the building paint [15]. Xu *et al.,* (2018) [16] indicated that improper materials, material ageing, low quality material and inferior materials can cause defects to the building during the building operation. Low quality material usually will not last long and will be damaged faster. The aging of the material will also cause the material's endurance to diminish. Each material has its own shelf life which will suffer damage slowly as it gets longer in use. In addition, poor communication and collaboration among architects, engineers, contractors and subcontractors can cause misunderstandings and misconceptions that cause the final quality of the product to be not at the optimum standard.

2.4 Building Defects' Remedial Actions

Currently, the development of technology has been widely practiced in the construction industry. New technology has a lot of positive effects in maintenance management and can reduce the occurrence of defects in buildings. Xu *et al.,* (2018) [16] noted that recent advances in building technology have reduced the incidence of defects to the building.

Proper building design will reduce damage to buildings as well as will facilitate building maintenance management [7]. In enhancing users' understanding of the value of keeping the building in good condition, management need to give some guidance to users on maintaining the building and how to properly use it [17]. It will last longer if used properly by the user. Using quality and sustainable materials is also one of the best practice strategies to maintain building condition. This is because the higher quality materials usually has a strong level of endurance and is able to last for a long time. Asmone *et al.,* (2019) [18] revealed that material quality management and sustainability of the materials can be achieved from efficient supervision when the construction process begins. The materials used must be non-damaged, characteristics are suitable for use and not bring negative weight from their use once the construction of the building is completed.

3. Methodology

This research paper used mix research method; qualitative and quantitative approach to obtain data and information that are accurate and important according to the research title whereby, literature review, case studies and interviews concentrated on building defect in commercial building in peninsular Malaysia. The gathered data and information were evaluated and ended with a suggestion and approach to have the best maintenance practice in commercial buildings in peninsular Malaysia. The methodology is an approach or method used in research to collect data, analyze data and draw conclusions [19]. It is a theoretical and technical platform used by researchers to conduct studies. It helps researchers decide on how best to collect data, such as using quantitative or qualitative methods, or a combination of the two [20]. For this study, qualitative methods were also applied because they are suitable for collecting data in line with the research objectives. Qualitative methods allow researchers to delve into the perspectives, views and experiences of study participants through in-depth interviews, thematic analysis and detailed observations [21]. Data for this study were collected using a building condition assessment (BCA). BCA is a process of evaluating

the physical condition of a building and its systems. It involves inspecting, testing and reviewing the structure and components of a building. A BCA can help identify any defects, damages, deterioration or risks that may affect the performance, safety or value of a building. BCA also provide an opinion by professional on the general condition of a building, advise on any urgent or future repairs and the likely consequences of non-repair if any building hazards. Therefore, it facilitates further study because this method allows for a clearer understanding of the type of defects, causes of defects and the necessary remedial actions to address the issues that occur in this building.

3.1 Case Study

Case studies refer to the study's action on a single case arising in everyday life and examining or analyzing the environment by performing a visual inspection of the case. For this research paper, few case studies were carried out based on few commercial buildings that have already been constructed in north Malaysia. The commercial buildings of the shopping complexes or malls have been selected in this case study. There were limitations for the selection of the case study building, namely that the building must be a commercial building of the shopping complex type and have been in operation for more than 20 years. Three shopping complexes were chosen: Kompleks Tun Abdul Razak (KOMTAR), Central Square and Prangin Mall. These buildings were selected because they met the required criteria.

3.2 Building Condition Assessment (BCA)

Visual observation of the site is the first and mandatory step in conducting the inspection. It is also conducted in accordance with the Code of Practice for Building Inspection Reports (CPBS 101). This observation is to identify all the defects found in the building at every corner and identify the reasons that cause the defects to occur. A five-point colour-coded rating system was developed and refined through experience gained during the initial and follow-up assessments and from sustained research and development. The five-point scale proved to be the most effective compared to other scales. However, a three-point scale is too coarse for reliable results, while a seven-point or more scale is too fine and difficult for assessment by staff to interpret consistently. Colour adds another dimension to reporting by making reports more user-friendly and accessible to non-technical users of the information. Colour also makes graphic reports more effective and easier to interpret (Tables 1 to 2). The condition assessment ratings are also linked to the related maintenance actions and types as shown in Tables 3 and 4 below.

Table 1
Priority fire safety assessment

Priority	Scale value	Description (Value)
Normal	1	Functional, only cosmetic defect
Routine	2	Minor defect, but can lead to serious defects if left unattended
Urgent	3	Serious defect, cannot function to an acceptable standard
Emergency	4	Element/structure does not function at all or risk that can lead to fatality and/or injury

There are several tools that are used with the aim of obtaining clearer information and facilitating the process of recording data devices such as cameras were used to store images of identified defects. Additionally, measuring tape is used to measure the length and area of a particular defect. All of the tools used were for identifying potential issues early and ensuring the safety, functionality and longevity of the structure.

Table 2
Condition survey rating

Rating	Type	Action matrix	Score
	Minor	Plain Maintenance	1 to 4
	Quite Significant	Condition Monitoring	5 to 12
	Serious Attention	Serious Attention	13 to 20

Table 3
Condition fire safety assessment

Scale value	Condition	Description
1	New/ As new	Minor servicing
2	Fair	Minor repair
3	Poor	Major repair
4	Very poor	Malfunction
5	Dilapidated	Damage / Missing

Table 4
Overall building rating

No.	Building Rating	Score
1	Good (Compliance)	1 to 4
2	Fair (Observation)	5 to 12
3	Dilapidated (Non-Compliance)	13 to 20

4. Results and Discussion

Three case studies were selected in this research. BCA were only carried out in public areas due to strict requirements set by the management and tenants for conducting studies within shop lots. Commercial buildings that are over 20 years old were typically chosen as they tend to have more damage compared to newer buildings, influenced by various factors. A total of 52 defects of various types were identified.

4.1 Types of Defects in Commercial Buildings in Malaysia

As shown in Table 5, cracking is ranked first in terms of defect found with the total number 20 out of 52. Cracks can be classified by non-structural and structural. The cracks that occurred were on the floor, column and wall. According to these findings, there were many factors that lead to this issue. Building cracks can arise from a variety of causes including thermal expansion and contraction, which create stress in the structure due to temperature fluctuations. Poor workmanship, such as inadequate foundations or substandard materials, can also lead to cracks and lack of experience and competency of labour must be considered as a factor contribute to poor workmanship [22]. Additionally, ground movement or soil settling can shift the building's foundation, causing structural stress. Moisture intrusion and subsequent drying can weaken materials and result in cracks, while excessive loads or vibrations from nearby construction can further exacerbate the issue. Proper design, quality construction practices and regular maintenance are essential to mitigate these risks and maintain the structural integrity of the building.

Table 5
Types of defect

Type of defect	No.
Cracked floor	6
Crack on column	6
Escalator failure	1
Damage ceiling	13
Crack on wall	8
Broken wall tile	1
Broken exits sign	1
Paint peeling on walls	8
Pipe leakage	2
Faulty light bulbs	6

4.2 Causes of Defects in Commercial Buildings in Malaysia

For reasons leading to building defects and failures (Table 6), the highest rate is material issues. According to Ahzahar *et al.,* (2011) [23], construction material is an important factor because the materials being used in construction will determine the behaviour of the structure and may result in many types of defects in the future if not taken seriously. Substandard or inappropriate materials can compromise the structural integrity and durability of the building. Additionally, defects can arise from improper handling, storage or mixing of materials, leading to weaknesses in the construction. Ensuring the use of high-quality, suitable materials and adhering to proper construction practices are crucial in preventing these defects and maintaining the building's longevity and safety.

Table 6
Causes of defect

Type of defect	Causes of defect
Cracked floor	Load stress (heavy load, impact load)
Crack on column	Load (overloading)
Escalator failure	Mechanical failure (wear and tear, poor maintenance)
Damage ceiling	Water damage; Aging and wear (material deterioration)
Crack on wall	Structural issue (load stress)
Broken wall tile	Structural movement (vibration)
Broken exits sign	Due to pipe leakage
Paint peeling on walls	Moisture issue (water leakage, humidity)
Pipe leakage	Aging and wear: Material Deterioration: Over time, pipe materials can degrade, becoming more prone to leaks. Joint Wear: Wear and tear at pipe joints can lead to leaks over time
Faulty light bulbs	Aging and wear (natural degradation, improper maintenance)

4.3 Remedial Actions for Defects in Commercial Buildings in Malaysia

For the remedial action for every identified defect (Table 7), the main cause of this problem must be identified initially before proceeding to the next step. For structural defects, it is more complex and requires closer observation. For example for cracks in the structure, the size of the crack must be recorded (width and length). Furthermore, the position and size of the crack should also be considered whether it is larger at the top or bottom. This is to determine the cause of the crack. Non-structural building defects such as water issues, must promptly be addressed to prevent further problems. Water issues can lead to damage to the ceiling and potentially affect electrical fittings.

After the leakage has been identified, corrective measures should be taken. Subsequently, monitoring is also necessary to ensure that the issue does not relapse. The use of high-quality materials is crucial to ensure material durability. If low-quality materials were used, it may lead to the problem recurring in the short term due to the low material resilience. Using high quality paint can provide high durability to the paint layer on the wall [24]. Apart from being resistant to moisture, it is also very suitable for outdoor use as it can block the sun's ultra-violet rays. Therefore, it can then reduce erosion on the buildings' walls. For components that can still be repaired, repair steps are strongly encouraged for cost-saving purposes. However, if replacement of a component is necessary due to irreparable damage, replacement steps must be carried out. Majority from the building defects found after the BCA showed only minor cracks. However, there were also some major cracks that occurred and most of them located in the building structure.

Table 7
Remedial action for defect in commercial buildings

Types of defects	Remedial actions for defect
Cracked floor	Identifying the underlying cause. Rectify to prevent future cracking, use a high-quality concrete filler or epoxy to seal the gap, ensuring its level with the surrounding floor.
Crack on column	Assess the extent of the crack and whether it affects the column's integrity, epoxy injection for smaller cracks or more extensive methods such as carbon fiber wrapping or steel plate reinforcement for larger or more critical cracks.
Escalator failure	Conduct repairs or replacements. Regular maintenance schedules should be established and followed rigorously to prevent future failures.
Damage ceiling	Identifying the cause such as water leaks, structural issues or environmental factors. Address any underlying problems, such as repairing roof leaks and/or fixing plumbing issues. Remove damaged materials. Install new ceiling materials.
Crack on wall	Apply a high-quality crack filler or patching compound.
Broken wall tile	Remove the broken tiles and clean the area, make sure clean from debris. Replace the broken tiles with new ones that match the size, style and color of the existing tiles.
Broken exits sign	Assess the extent of the damage and determine if the sign can be repaired or if it needs replacement. If repairable, carefully remove the broken parts and replace them with suitable components. Install a new exit sign is necessary.
Paint peeling on walls	Addressing the underlying cause. Scraping off loose and peeling paint. Sand the area lightly to smooth out any rough edges and ensure a clean surface. Wash the wall. Apply a primer. Lastly, apply a high-quality paint.
Pipe leakage	Locating and repairing the leak in the pipe.
Faulty light bulbs	Remove the faulty bulb and inspect the socket for any signs of damage or corrosion. Clean the socket if necessary and ensure it is dry before installing a new bulb.

5. Conclusions

Commercial buildings are important because it can encourage economic growth by offering beneficial spaces for a range of commercial activities like business activities. Commercial buildings can also develop an urban area by the design and architecture of the building that contribute to the overall aesthetic and functionality of urbanization. Building defects are still happening and action must be taken to counter this problem from continuing to worsen. The awareness of all parties is very important, especially the tenant as they use and occupy the building each day. If this problem is not addressed immediately, it will affect the safety of the users. The level of comfort of the users is also very important to enhance the activities, especially the business carried out in the building. Effective building maintenance management of commercial buildings will impact various aspects including building performance, operation, functionality and quality of how the building is maintained. Well-maintained services will bring comfort to users and tenants alike.

Discomfort, such as an unclean and unsafe environment will reduce the number of users. Tenants will also seek buildings that are safer and more affordable in line with their expenses. This will result in poorly managed buildings having fewer visitors, ultimately leading to a decline in visitors for those buildings. In general, there are many building defects that occur, and less action taken to solve this problem. Besides that, there are some best practice strategies that can be taken to maintain the building performance from building defects that the researcher proposes. It is the understanding of the importance of the condition and structure of the building so that tenants take more weight on the issues that apply to the building they rent. High knowledge of building maintenance will allow them to manage the building well from the occurrence of any defects. Actions can also be taken in addressing defect problems at an early stage if tenants know the necessary actions to be taken to address the problems before they worsen.

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