CONCEPTUAL DOMAIN MODEL FOR MAINTENANCE MANAGEMENT OF HIGH-RISE RESIDENTIAL STRATA

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ABSTRACT:

Due to urban regions' lack of land for housing and infrastructure development, multi-level (vertical) constructions have developed rapidly. Massive developments and integration of high-rise buildings and structures, such as multi-story houses and apartments, are now prevalent in Malaysia. When it comes to the housing industry, preventive maintenance is critical because it helps individuals maintain their daily routines while also enhancing the productivity of activities in and around their residences. Therefore, the primary focus of this research is to review the temporal strata maintenance issues, build a conceptual domain model for maintenance procedures of residential strata in Malaysia, and link it with existing Land Administration Domain Model (LADM) packages. Furthermore, a Unified Modeling Language (UML) model for this LADM extension was created and is presented here on a conceptual level. This conceptual domain model for maintaining high-rise residential strata is designed by identifying the actors, classes, and their relationships derived from literature review, then created in the Enterprise Architect software. This conceptual domain model can further be used to develop maintenance management databases and software, which are nowadays essential for effective strata maintenance management.

1. INTRODUCTION

In metropolitan regions, growth in population and infrastructure development have increased space use. Space usage is no longer limited to the ground surface but now extends to space above and below the earth's surface. Strata developments have developed from a need for people who wants to live in expensive metropolitan areas to a lifestyle trend among Malaysia's urban professional community (Che Ani et al., 2010). Multi-level and vertical constructions have evolved in metropolitan areas due to a shortage of residential land and infrastructure projects. In Malaysia's major cities, massive expansions and usage of elevated building structures, such as multi-story apartments and overpass structures, have revealed that the demand for space above ground has increased dramatically in recent years (Budisusanto, Aditya, & Muryamto, 2013; Rabe, Osman, Abdullah, Ponrahono, & Aziz, 2021). The rate of living in strata buildings will be increases in the future (Mohd Nor, Wan Abd Aziz, & Al Sadat Zyed, 2020). These multi-story elevated residential strata need systematic building management and maintenance systems, which the tenants expect to increase the strata's lifestyle.

Building management and maintenance systems are complicated fields encompassing the interplay of technical, social, administrative, and financial elements to determine how buildings will be used (Shubashini, 2016; Yik, Lee, & Ng, 2002). Most individuals are unaware that a building maintenance system contributes to the revenue of a corporation that owns or rents a property. It, along with other aspects such as productivity, quality, safety, and the environment, has become a part of a complete performance approach (De Groote, 1995). It is hard to analyze the maintenance performance as it depends not only on quantifiable indicators but also on the quality of the maintenance work (Armstrong, 1987). Facilities and building management are important in the housing business since it helps to support people's everyday routines while also increasing the productivity of activities in and around their homes (Au-Yong, Ali, & Chua, 2018). Many maintenance management bodies in high-rise structures have observed inadequate planning, a lack of proactive maintenance methods, and poor maintenance task execution. As a result, several complaints about the poor state of residential strata have been recorded (Karim, 2012). Nonetheless, the Malaysian government has not fostered or adopted facilities management in any systematic fashion. In Malaysia, the need for building care, particularly preventive maintenance in housing, is frequently overlooked (Abdullah, Zubedy, & Najib, 2012).

On the other hand, high maintenance costs are a major concern in the building sector. The general public overlooks the need for building maintenance due to the high maintenance cost without thinking about the consequences (El-Haram & Horner, 2002). Maintenance work is budgeted and conditionally executed in Malaysia. Maintenance is only carried out when funds are available. Furthermore, maintenance work is done only when there is a failure in any amenity or some replacement is required, which is the remedial basis (Lateef, 2009). Although proactive maintenance has been established and demonstrated as beneficial compared to traditional maintenance techniques, the latter is still widely used in the residential strata industry (Nik-Mat, Kamaruzzaman, & Pitt, 2011). Then, despite the government's attempts, building maintenance has been a poor practice in Malaysia. The general population is unaware of its significance (Au-Yong et al., 2018). However, a good maintenance management strategy is essential for increasing the life span of a building and reducing unexpected breakdowns or degrading effects (Zawawi & Kamaruzzaman, 2009). Instead of hiring contractors, most buildings are maintained by their own workers. Hotels, hospitals, and high-rise structures often have their own maintenance department, which is overseen by a maintenance

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manager but does not have the proper maintenance equipment and knowledge compared to a professional maintenance contractor (Zawawi, 2006).

2. RESEARCH PROBLEM

The amenities offered by high-rise buildings attract individuals to reside there. These amenities must be adequately maintained. It is indisputable that preventive maintenance is critical in high-rise residential buildings to enhance the lifespan of a building, assure the comfort and security of tenants, and maintain the property's worth. A residential structure serves as a shelter for people who spend most of their time there and a place for residents to unwind after a long day at work. As a result, residential facilities are now available to help their daily routine and improve their lifestyle and quality of life (Au-Yong et al., 2018).

The amenities and features of these buildings cannot work properly without competent maintenance management (Abd-Wahab, Sairi, Che-Ani, Tawil, & Johar, 2015). However, present property management techniques in Malaysia have shown a slew of issues that affect all parties, including developers, property managers, owners, and tenants of high-rise strata (Azian, Yusof, & Kamal, 2020). A high-rise residential building's extensive facilities and services necessitate frequent maintenance (Au-Yong et al., 2018). (Seeley, 1987) categorized the maintenances in the following categories as shown in the Figure. 1

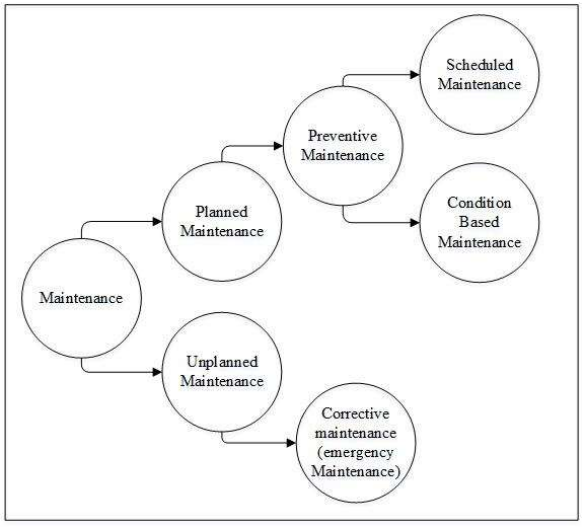

Figure. 1 Categorization of Maintenance

Maintenance that is structured and carried out with foresight, control, and the use of records according to a preset plan is known as planned maintenance. At the same time, unplanned maintenance is non-predetermined (Seeley, 1987). Meanwhile, major breakdowns can be avoided if a skilled property manager is trained in this area. Preventive maintenance ensures a building's effectiveness by inspecting and repairing it regularly. The goal is to identify minor issues before they become large and costly. Corrective maintenance includes repairs to the building and equipment due to natural wear and tear or improper preventive maintenance. Regarding equipment issues, it's sometimes unclear whether the item should be repaired or replaced (Arditi & Nawakorawit, 1999). Condition-based maintenance is launched as a result of continuous monitoring of an item's condition and scheduled maintenance performed at predefined intervals.

Separate numerous residences share the same lot of land in high-rise residential buildings. This style of structure includes covered parking, a waste chute, elevators, lawns, and a swimming pool (Abd-Wahab et al., 2015). (Jamil et al., 2017) categorize the mentioned facilities in the way of ownership and usage, as shown in Figure 2.

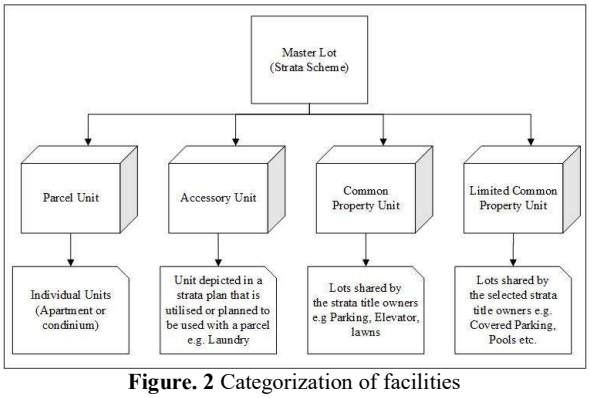

Figure. 2 Categorization of facilities

Due to the complex division of facilities in residential strata and multiple management bodies, an executable model is required to perform proactive maintenance for strata. The implementation is not straightforward when a 3D space is incorporated. This is evident in a number of ways, including the employing it (S Azri, Ujang, & Rahman, 2019; Basir, Majid, Ujang, & Chong, 2018; Köninger & Bartel, 1998; Suhaibah, Uznir, Rahman, Anton, & Mioc, 2016), data management (Suhaibah Azri, Anton, Ujang, Mioc, & Rahman, 2015; Yanbing, Lixin, Wenzhong, & Xiaomeng, 2007) and integration with sophisticated decision evaluation (Suhaibah Azri, Ujang, Rahman, Anton, & Mioc, 2014; Kwan & Lee, 2004; Mohd & Ujang, 2016). Therefore, the focus of this research is to review the temporal strata maintenance issues, build a domain model for the maintenance procedure of residential strata in Malaysia and link it with existing Land Administration Domain Model (LADM) packages to identify the actors involved in the maintenance of residential strata's and to develop a sequence of work involved in maintenance. On the conceptual level, a Unified Modeling Language (UML) model for this LADM addition was produced as part of the maintenance process and is presented in this research. The literature review identifies classes for the domain model and actors involved in maintaining high residential strata.

3. METHODOLOGY

Land Administration Domain Model (LADM) defines basic classes such as 2D and 3D spatial units and rights, rules, and restrictions (RRR) that can be used to register and visualize 3D property objects for land and space registration. The LADM makes it easier to set up land administrations efficiently. It has the potential to serve as the backbone of any land administration system (van Oosterom & Lemmen, 2015). The maintenance management domain model is drawn in Enterprise Architect software and then joined with LADM existing basic domain model. Temporal strata management is directly associated with LA_BAunit, i.e., Land administration Basic administration Unit, whereas Management Corporation (MC) and Subsidies Management Corporation (sub-MC) will be related to the RRR package of LADM. Figure 3 shows the complete maintenance domain model and its association with LADM. Furthermore,

attributes of each class of maintenance package are identified with the help of literature. Use cases and sequence diagrams are also drawn in Enterprise Architect, which will be shown in the result section of this paper.

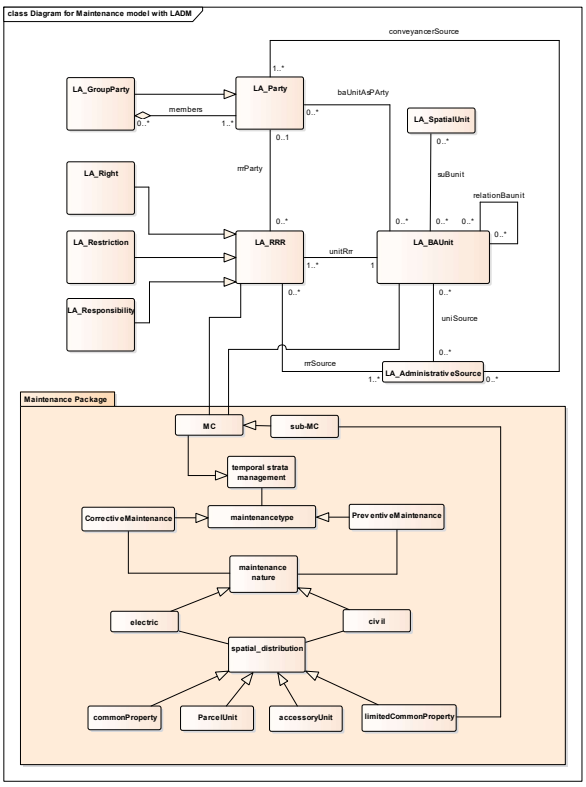

Figure. 3 Maintenance Domain model with LADM

4. RESULTS

As discussed earlier, preventive maintenance is more advantageous compared to corrective maintenance. The conceptual domain model for maintenance is divided into two types, i.e., Preventive maintenance and corrective maintenance. MC is responsible for the maintenance of the common property and limited common property, and usually, in residential strata, the tenant is responsible for maintaining his parcel unit. But MC can provide services and Human resources to tenants to maintain their parcel units. For common properties, MC usually collects a maintenance fund from the tenants of strata. Figure 4 shows a conceptual domain model for the maintenance of residential strata with the classes and attributes. In residential strata, MC has to oversee the maintenance work, especially for common properties of the strata. MC collected a maintenance fund from the tenants to maintain the structure. Here strata are divided into four classes as per their ownership. Parcel and accessory units belong to tenants to look after their maintenance and common property, and limited common property is to be looked after by the MC. Further corrective and preventive maintenance classes are linked to the main maintenance class and a unique ID.

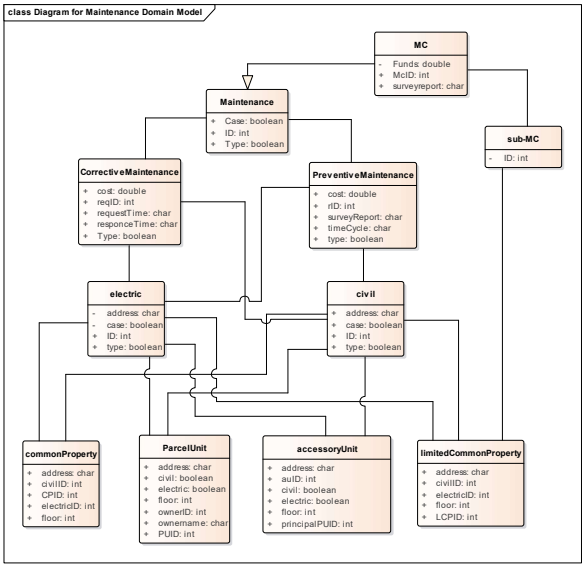

Figure 4. Maintenance Domain Model

Use case diagrams for preventive and corrective maintenance are drawn in Enterprise Architect software. Use Case explains the interaction between a system and its environment, which an external actor initiates to achieve a goal (Bertolino, Fantechi, Gnesi, Lami, & Maccari, 2002). Here, in the case of corrective maintenance, or it can be said as emergency maintenance, the strata tenant must make a request call on the system that is applicable in the building. The tenant will act as a primary actor as he has to initiate the whole process of maintenance, as in this case. The other actors involved in the systems are secondary actors, i.e., MC and contractors. With his request, the tenant has to give the address of where maintenance is required and also has to describe the type of maintenance, whether it has to be replaced or repaired. After getting the tenant's request, MC first checks his budget and then issues a work order to the contractor responsible for providing services for the said strata. Further, after the inspection contractor sends the type report to MC whether it needs to be repaired or replaced, MC gives approval, and then the contractor executes the said job. Use case diagram, use case description, and sequence diagram of the whole process is shown in Figure 5, Table 1, and Figure 6, respectively.

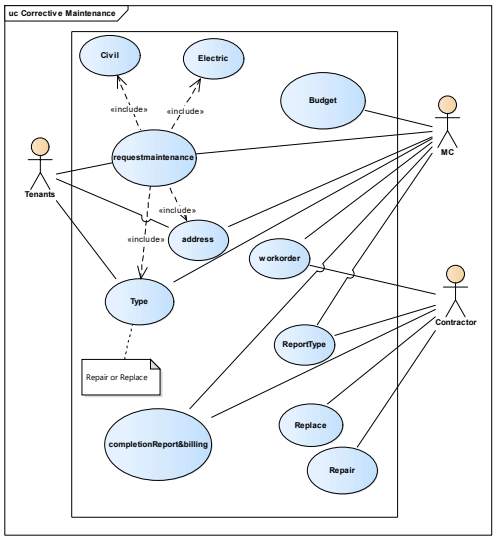

Figure 5. Use Case Diagram for Corrective Maintenance

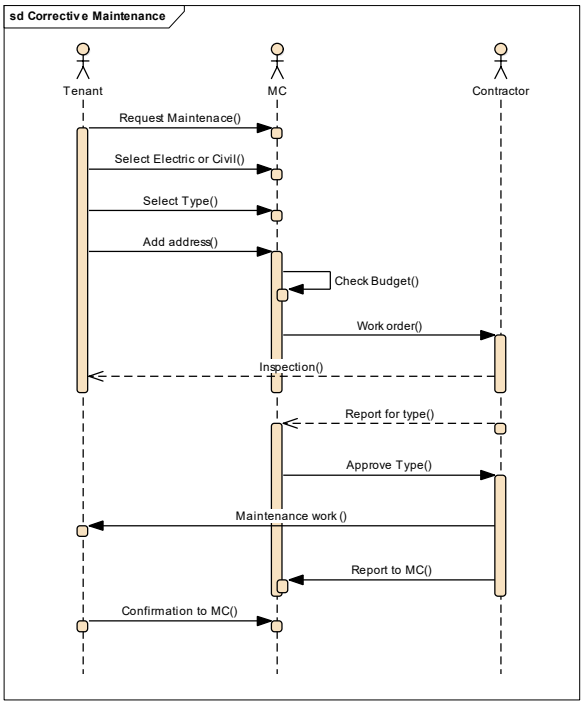

Figure 6. Sequence Diagram for Corrective Maintenance

Use Case	Description
requestmaintenance	Maintenance requests initiated by the tenant when required
Type	Whether the tenant required a repair or replaced
address	Address of apartment, accessory unit, or common property where maintenance required must be input by the tenant
Budget	MC has to check the budget.
Workorder	MC will issue a work order to the contractor
Reporttype	Contractors must report to MC before executing the job whether the fault has to be repaired or replaced.
Replace	The contractor will replace the faulty item
Repair	The contractor will repair the faulty item
CompletionReportandBilling	The contractor will send the execution report and bill to MC
Actors	**Description**
Tenants	Primary actor- Resident of Strata
MC	Secondary actor – Management Corporation responsible for maintenance
Contractor	Secondary actor – Person or party who provides maintenance services

Table 1. Use Case Description

Now, in the case of preventive maintenance, the MC decides the frequency and time interval for maintenance. The contractor will provide human and technical resources for the job with MC's consultation. Furthermore, before the maintenance contractor and MC mutually inform the tenants and execute the job, the contractor has to send the billing and final report to MC. Figure 7 shows the use case diagram for preventive maintenance, and Figure 8 shows the sequence of work for preventive maintenance.

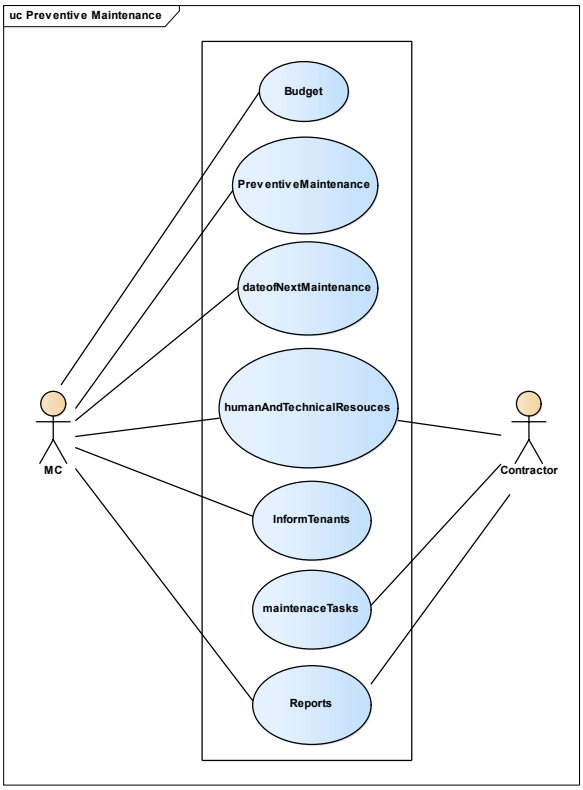

Figure 7. Use Cases for Preventive maintenance

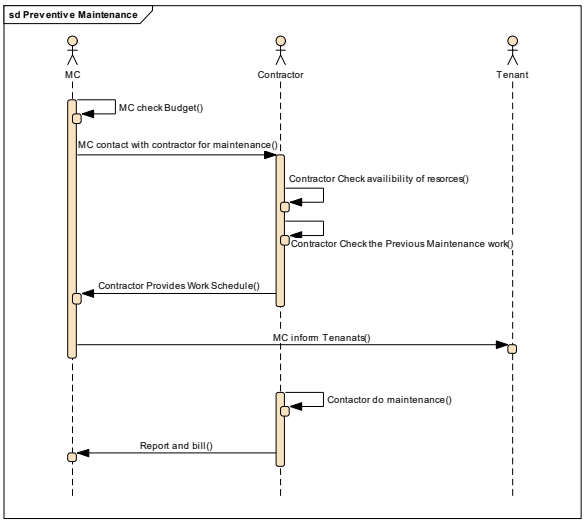

Figure 8. Sequence Diagram for Preventive Maintenance

5. DISCUSSION AND CONCLUSION

As the population increases, high-rise residential strata development has increased rapidly in the past years. These residential strata give its tenant a facilitated lifestyle and support a professional lifestyle. Still, tenants have to share more common facilities in elevated strata. Systematic management is much needed for each residential strata to maintain a quality life standard and increase the strata's life span. It is also concluded that proactive and preventive maintenance systems are more advantageous compared to corrective maintenance. Preventative maintenance can dramatically reduce the risk factors of mishaps and disasters. It is found that some strata's building staff do

maintenance work, as the staff is not professional, which may output poor quality of maintenance work. A professional maintenance firm should be contracted to do preventive and corrective maintenance, which will be responsible for the quality of work.

Most residential strata strive for maximum tenant happiness, a good reputation, the most cost-effective operation, and maximum profit. High quality, proactive maintenance is the key to maintaining high resale values of apartments and good references for developers and management. For MC and Developers, Maximum tenant satisfaction and a high reputation can be achieved by effectively communicating with strata residents, methodically managing maintenance work, and taking steps to remove dangers and hazards. Strata living is likely to improve if property managers communicate effectively with tenants, are aware of their issues, and take steps to address them. If property managers are in continual touch with designers during the design phase and after the building is put into operation, certain of the users' maintenance-related complaints are unlikely to arise.

A digital and systematic maintenance system is necessary for the high-rise strata. This research presents a conceptual model to develop computerized databases and software to perform maintenance management. Further, it is essential to identify other temporal strata management issues that may be the research direction for authors in the future.

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