

Critical Issues in The Operation of Vertical Transportation in High-Rise Affordable Residential Buildings

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ABSTRACT

The demand for affordable buildings in urban areas has increased in high-rise residential buildings, where vertical transportation systems like lifts are essential. However, inadequate maintenance often in safety issues, breakdowns and reduced resident satisfaction. This study examines the challenges of maintaining lifts in three (3) affordable residential buildings developments in the Klang Valley, Malaysia, using a mixed-methods approach with data from 300 residents and interviews with building managers. Key findings highlight the impact of funding constraints, lack of expertise and poor planning on lift maintenance, with moderate resident satisfaction across safety, comfort and performance. The study recommends improved funding, standardised protocols and resident awareness campaigns to enhance lift operations and safety.

INTRODUCTION

High-rise, affordable residential buildings often rely on lifts to provide efficient access to multiple floors. However, in many cases, the maintenance of these lifts is inadequate, leading to frequent malfunctions, safety risks, and accidents. Recent incidents, such as the tragic death of a child in a People's Housing Project (PPR) due to poor lift maintenance; highlight the severity of these issues. The lack of payment for maintenance services, insufficient planning, and the absence of skilled professionals are significant contributing factors to these buildings' poor operation of vertical transportation systems.

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LACK OF MAINTENANCE FEES

One (1) of the most critical issues in the operation of lifts in these buildings is the failure of residents to pay maintenance fees. Many residents neglect their financial obligations, assuming that the local authorities will bear the cost of maintenance. This lack of payment deprives maintenance teams of the necessary resources to carry out essential repairs and replace worn-out components. Inadequate funding results in delayed repairs, leading to further deterioration of lift systems. To address this, it is essential to implement an awareness campaign that educates residents about the importance of paying maintenance fees, emphasizing their role in ensuring building safety and functionality.

LACK OF MAINTENANCE PLANNING

Effective maintenance planning is crucial for the proper operation of lifts. Regular inspections, scheduled repairs, and timely parts replacement are essential to maintaining a lift's operational efficiency and safety. However, maintenance planning is non-existent or insufficient in many low-cost residential buildings. Aliyu (2015) points out that poor planning, lack of funding, and limited expertise contribute to the rapid deterioration of vertical transportation systems. Maintenance teams often fail to perform routine checks or address minor issues before they escalate into problems that are more significant. Establishing a comprehensive maintenance plan, including routine inspections, preventative measures, and emergency protocols, can significantly improve the reliability of lifts in these buildings.

LACK OF SPECIALIST EXPERTISE

Another major issue in maintaining lifts in residential buildings is the lack of specialised expertise. Aliyu (2015) emphasises that lift maintenance requires specialised knowledge and skills that general maintenance personnel may not possess. Lifts are complex machines with various components that require specific knowledge to diagnose and repair. Without skilled professionals, maintenance teams may struggle to identify issues, resulting in extended downtime and potential safety hazards. Hiring qualified technicians with expertise in vertical transportation systems is essential to ensure that lifts maintain properly and operate safely.

THE PRACTICE OF MAINTENANCE MANAGEMENT

According to Lateef (2009), in Malaysia, the preservation of homes is growing regardless of length, kind, vicinity, and ownership. The current preservation control approaches in Malaysia are condition- and reactive-based. The weaknesses within the cutting-edge methods are the number one (1) issue. Therefore, constructing renovations is becoming a first-rate pastime because substantial resources dedicated to them. After all, the government is recognising the want for building renovation. This will likely be the case in the years ahead, as homes require maintenance so that you can perform efficaciously.

As Chen et al. (2023) said, elevators and escalators are the main types of vertical transportation in multi-story and high-rise buildings; stairs are also added when there is a significant height difference. Part of that is maintaining the system operational, which is essential, especially for disabled persons who depend on escalators and elevators for their transportation desires and inconvenienced whilst the system breaks

down. This energetic involvement with the aid of the disability network has helped companies recognise the significance of imparting reliable escalators and elevator providers (Somasekaran, 2024).

Furthermore, Chandra Dahal & Raj Dahal (2020) stated that the monetary and commercial defects are insufficient to finance manner protection management in the employer. Furthermore, it requires more systematic devices and value-powerful strategies than the conventional procedures currently used in Malaysia. As stated by Zawawi et al. (2010), even though the concept of building maintenance already exists in Malaysia, the everyday practices and approaches still require adjustments to align with modern conditions and demands. According to several stakeholders, building maintenance is a complex and costly process. However, if carried out properly, it can lead to cost savings and potentially extend the lifespan of the building.

MAINTENANCE OPERATION OF VERTICAL TRANSPORTATION

Vertical transportation is essential for high-rise buildings. Vertical transportation can be either a lift or an escalator. According to Isnaini Janipha et al. (2018), regular maintenance is necessary to ensure that the escalator functions properly and is safe to use. Vertical transportation equipment can help passengers move between floor levels of a building (Godwin, 2023). Every lift has its categories according to the function, such as trade lift and hospital lift, high residential lift, institution lift and store lift. Another type of vertical transportation is the escalator used in commercial buildings such as shopping malls. It has the same function as the escalator which moves passengers, floor by floor.

The competent contractor lift can carry out installation, major alterations, replacement works and maintenance of the lift if the person is register with the Building and Contractor Authority. Periodic maintenance and inspections are crucial to keep lifts running safely and reliably to reduce breakdown and maintenance cost. Vertical transportation maintenance includes cleanliness, lubrication, adjustment, inspection, testing and review.

Type of Maintenance

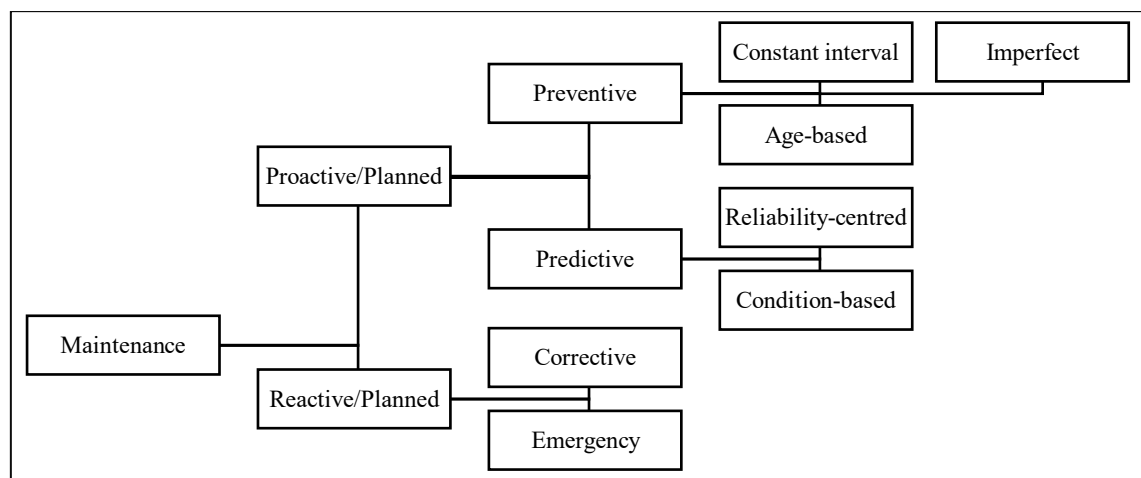


Fig. 1. Types of Maintenance

Source: Authors (2024)

According to Dhillon (2002), maintenance is divided into unplanned and planned. It categorised into three (3) categories: preventive, corrective and predictive.

Table 1. Definition of Preventive Maintenance, Corrective Maintenance and Predictive Maintenance

Preventive maintenance	Periodic or Time-Based Maintenance: Regularly conducted to ensure equipment reliability. Focus on known Conditions: Maintenance based on the machine's current condition. Failure Detection: Aims to address issues that cannot detected beforehand. Attention and Judgment: Maintenance is performed based on the best judgment and capability of the planner. Scheduling: Based on maintenance guidelines and manufacturer recommendations.
Corrective maintenance	Correct maintenance is a renovation undertaking or operation done to become aware of, isolate, and rectify a specific fault. Costs associated with corrective preservation consist of restored prices, misplaced manufacturing and misplaced income.
Predictive maintenance	Modern measurement and signal processing methods anticipate and diagnose equipment or equipment conditions accordingly for the duration of an operation. The nature and requirements of the modification have extensively modified. The maintenance function has evolved to become not more technical, clinical and complex but more distinguished, urgent and paying.

Source: Authors (2024)

Legal Requirement for Vertical Transportation

Table 2. Legal Requirement for Vertical Transportation

Item	Occupation Health and Safety Act 1993	Uniform Building by Laws 1984	Malaysian Standard 1184:2014
Installation and maintenance standards	/	/	/
Safety measures	/	/	/
Training and awareness	/		
Responsibilities and duties	/		
Record-keeping	/		
Penalties and enforcement	/		
Accessibility		/	/
Maintenance, testing and inspection		/	/
Design specifications and criteria			/

Source: Authors (2024)

People's Requirement for Vertical Transportation

Table 3. People Requirement for Vertical Transportation

Safety	Crime Deterrent as to potential criminal activities Collection of Evidence: Kirui (2024) stated that CCTV systems are valuable tools for collecting evidence.
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	Enhanced Monitoring: Security guards can effectively monitor areas through CCTV cameras without constant physical patrolling. Quick Response and Prevention: This quick response can prevent incidents from escalating or assist in apprehending offenders promptly. Sense of Safety: CCTV systems can instil a sense of safety and security among individuals within the monitored areas.
Comfortable	Respecting Personal Space: It is a general courtesy to stand at a reasonable distance from others and avoid unnecessary physical contact. Conversational Volume: Elevator rides are often brief, and loud conversations might be disruptive. Eye Contact: Respecting this and maintaining a neutral or relaxed gaze without intense or prolonged eye contact can help people feel more at ease. Awareness of Surroundings: It is key to be considerate of others' comfort and ensure that one's actions and behaviours do not make fellow passengers feel uneasy or uncomfortable. Respecting Diversity of Personalities: Recognising that individuals have different personalities and comfort levels is important.
Performance	Energy Conversion: This energy converted into potential energy when lifting passengers and objects. Regenerative braking systems can sometimes recover some of this energy during descent. Counterweight: The counterweight is a crucial part of elevator systems. Guide Rails: Elevator cars run along vertical guide rails, ensuring stability and preventing lateral movement. Safety Mechanisms: Elevators incorporate various safety features. Multiple Safety Systems: Modern elevators have multiple safety systems, like redundancy in suspension bridge cables. Safety Standards and Regulations: Elevators are subject to strict safety standards and regulations to ensure proper design, installation, and maintenance.
Complexity	Elevator installation requires high-tech equipment due to the critical nature of elevator spare parts for human safety. It might be the poor workmanship of maintenance workers, which could arise from the employment of inexperienced foreign workers on construction sites. Elevator spare parts are expensive for building owners. Therefore, periodic maintenance is necessary to ensure smooth elevator operations and prevent problems when people use the lift. Additionally, the installation process requires high-quality work, prioritising safety, and providing good service to end-users.
Effectiveness	Service Points: Regular servicing is required for door operating equipment, ventilation systems at the top of the car, and safety mechanisms at the bottom, typically performed within the hoist way. Flooring Maintenance: Elevator flooring be kept clean, and when refinishing, non-slip and non-flammable materials should be used. Routine Maintenance Checklist: Key operational elements such as response time, travel speed, door functions, stopping smoothness, light indicators, and floor accuracy regularly checked and corrected. Periodic Review and Modernisation: Elevator systems should undergo periodic reviews to ensure proper maintenance and identify components needing modernisation. Frequency of Maintenance: Maintenance should be performed more frequently than scheduled inspections to ensure optimal safety and performance.

Source: Authors (2024)

METHODOLOGY

This study examines the residents and stakeholders involved in the maintenance of vertical transportation systems within high-rise low-cost residential buildings. The research was conducted at three (3) PPR buildings in the Klang Valley such as PPR Lembah Subang 2, PPR Taman Putra Damai and PPR HICOM

Shah Alam. A mixed-methods approach was integrating both quantitative and qualitative methods to achieve a comprehensive understanding of the issues.

The target population includes the residents who use the lift systems and the personnel responsible for their maintenance. A sample size of 100 respondents per site selected randomly to participate in the quantitative survey. This ensured adequate representation of diverse resident experiences. Additionally, semi-structured interviews conducted with building managers and maintenance supervisors from each PPR to explore qualitative insights into the maintenance operations and challenges.

The questionnaire for the survey was designed based on factors identified in the literature, focusing on five (5) key dimensions of vertical transportation systems: safety, comfort, performance, complexity, and effectiveness. The interview questions were structured to delve deeper into operational challenges and practices.

DATA COLLECTION AND ANALYSIS

Quantitative data collected through structured questionnaires distributed randomly to residents of the selected PPR buildings. The survey employed a 5-point Likert scale ranging from one (1) ("Strongly Disagree") to five (5) ("Strongly Agree") to evaluate residents' satisfaction with key aspects of vertical transportation systems. These included lift reliability, environmental conditions such as cleanliness, odours and lighting, safety features such as emergency lighting and CCTV and overall system performance. This approach provided measurable insights into the residents' perceptions and experiences with lift operations, enabling a comprehensive assessment of user satisfaction.

Qualitative data were gathered through semi-structured interviews with building managers and maintenance supervisors at the selected PPR buildings. The interviews explored various topics, such as the frequency and scope of maintenance activities, resource and funding constraints, the impact of resident behaviour on maintenance practices, and the absence of formal maintenance policies or guidelines. These interviews provided a detailed understanding of the operational and contextual challenges of maintaining vertical transportation systems.

The quantitative data were analysed using weighted mean calculations to evaluate satisfaction levels across the five (5) key dimensions of safety, comfort, performance, complexity and effectiveness. This analysis helped to identify patterns and areas requiring improvement in the operation and maintenance of the lift systems. Meanwhile, qualitative data analysed thematically to uncover recurring patterns and unique challenges. Key points included funding limitations, inconsistent maintenance practices and resident-related issues such as vandalism and non-payment of maintenance fees.

By integrating both quantitative and qualitative methods, the analysis provided a holistic view of the current state of vertical transportation systems in the selected PPR buildings. This dual approach highlighted critical areas for improvement and offered actionable insights for stakeholders to enhance the operation and maintenance of lift systems.

RESULTS AND FINDINGS

To determine the maintenance operation of vertical transportation effect on building occupants and other stakeholders. The resulting outcome based on the analysis consisting of:

Questionnaire

Table 4. Scale of Satisfaction Level

1	2	3	4	5
Strongly Disagree	Disagree	Medium	Agree	Strongly Agree

Source: Authors (2024)

The respondents were asked about their satisfaction level with safety, comfort, performance, complexity, and effectiveness. The questionnaire's analysis will be based on the satisfaction level scale and the weighted mean to calculate the data collection. Below are formulas that are used to get the mean;

$$\text{Weighed of Mean} = \frac{\sum (\text{Total of Respondents} \times \text{Scale})}{\text{Total of Respondents}}$$

Table 5. Mean for Satisfaction Toward Safety

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
Lighting Emergency	3.16	3.36	3.20
CCTV for safety purposes	2.88	3.04	3.00
Elevator door	3.28	3.36	3.36
The condition of the elevator	3.28	3.40	3.28
Safety bell rings are available	3.26	3.46	3.32

Source: Authors (2024)

Safety is a fundamental concern in the operation of lift systems, particularly in multi-storey residential buildings where the failure of lifts can significantly harm residents. Among the factors contributing to lift safety, emergency lighting, CCTV, functional elevator doors, and safety bells are essential. While emergency lighting received moderate satisfaction (Mean: 3.16–3.36), CCTV for safety purposes scored lower (Mean: 2.88–3.04), suggesting enhanced security measures were needed. Functional elevator doors and safety bells also contributed positively to residents' sense of security, with satisfaction scores exceeding 3.20 across the buildings. A critical issue affecting lift safety is the lack of maintenance payments, with many residents assuming that local authorities will cover maintenance costs. This assumption deprives maintenance teams of the resources needed to conduct repairs and replace components, delaying critical safety measures. An awareness campaign must educate residents about their responsibility to pay maintenance fees, emphasizing the direct link between timely payments and building safety.

Table 6. Mean for Satisfaction Towards Comfortable

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
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Good condition and clean	3.26	3.50	3.28
Elevator too crowded	2.90	3.12	3.00
Bad smelly	2.70	2.62	2.84
Good in lighting	3.42	3.62	3.48
Air condition is in good condition	3.16	3.10	3.26

Source: Authors (2024)

Comfort in lift systems often influenced by cleanliness, lighting, and environmental factors such as overcrowding and odours. Cleanliness (Mean: 3.26–3.50) and lighting (Mean: 3.42–3.62) were identified as significant contributors to comfort. However, overcrowding (Mean: 2.62–2.90) and unpleasant odours further diminished resident satisfaction. These factors are typically a result of insufficient maintenance planning and a lack of proactive management. Maintenance teams often fail to address minor issues before they escalate into more significant problems, as mentioned by Aliyu (2015), highlighting the need for regular inspections and prompt responses to environmental concerns. Building management should ensure that routine cleaning and ventilation systems are adequately maintain and that overcrowding is managed through clear communication with residents to enhance comfort. These measures and implementing a comprehensive maintenance plan will contribute to an improved experience for lift users.

Table 7. Mean for Satisfaction Toward Performance

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
Energy use	3.30	3.36	3.24
Counterweight of elevator	3.32	3.40	3.30
Safety brake of elevator	3.38	3.44	3.46
Speed governor	3.34	3.42	3.36
Safety system of elevator	3.38	3.52	3.42

Source: Authors (2024)

The performance of lift systems, including energy efficiency, safety mechanisms, and operational speed, is crucial to ensuring smooth and reliable service. Satisfaction with performance factors such as energy use, safety systems and speed governors ranged from 3.24 to 3.52, reflecting the importance of these technical aspects. However, these systems often experience downtime or malfunction due to insufficient maintenance, inadequate funding, and a lack of skilled professionals. The moderate satisfaction scores for performance highlight the importance of specialised expertise in maintaining lift systems. Building management must prioritise the recruitment and ongoing training of qualified personnel to handle the complexity of modern lift systems, ensuring that performance standards consistently met.

Table 8. Mean for Satisfaction Toward Complexity

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
High-tech equipment	3.36	3.32	3.20
Quality of components lift	3.44	3.34	3.36
Cost of components lift	3.36	3.32	3.36

Poor workmanship	3.10	3.00	3.48
Installation time	3.32	3.30	3.30

Source: Authors (2024)

Lift systems sophisticated, requiring high-quality components and technical expertise for proper maintenance. Satisfaction with high-tech equipment and quality components scored moderately (Mean: 3.20–3.44), but poor artistry received the lowest satisfaction scores (Mean: 3.00–3.48). These issues often arise from maintenance personnel lacking specialised knowledge and skills. Aliyu (2015) underscores the importance of employing skilled technicians who can effectively handle the complexity of lift systems and address issues before they lead to prolonged downtime. To resolve this, building management should invest in training programmes to develop a skilled workforce capable of maintaining complex lift systems. Using high-quality components and proper installation techniques will also reduce the risk of system failures and improve overall satisfaction.

Table 9. Mean for Satisfaction Toward Effectiveness

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
Response time	3.10	3.14	2.90
Travel time between floors	3.24	3.30	3.18
Door operation	3.32	3.40	3.24
Starting and stopping	3.28	3.60	3.36
Hall, call light and floor indicators	3.22	3.54	3.32

Source: Authors (2024)

Operational efficiency is critical to the overall effectiveness of lift systems. Key factors such as response time, travel time, and door operation were moderately rated (Mean: 2.90–3.40). These operational inefficiencies often stem from delayed or insufficient maintenance, which compromises the overall performance of the lift system. To enhance operational effectiveness, it is vital for building management to establish a comprehensive maintenance plan that includes routine inspections, preventative maintenance, and emergency protocols. Regular performance reviews and feedback loops will help identify areas for improvement and ensure that lifts operate optimally.

To Identify the Existing Implementation of Maintenance Operation of Vertical Transportation in High-Rise Low-Cost Residential Buildings

Interview

Based on Table 10, the interview analysis in this study were conducted with key personnel responsible for the maintenance and operation of vertical transportation systems in three (3) different PPR located in the Klang Valley: PPR Lembah Subang 2, PPR Taman Putra Damai, and PPR HICOM Shah Alam. These interviews aimed to assess the current implementation of maintenance operations for vertical transportation and identify any challenges or issues encountered by the management teams in these high-rise low-cost residential buildings.

Table 10. Summary of Interview Findings from Management Personnel of Selected PPR Sites

Description	PPR Lembah Subang 2	PPR Taman Putra Damai	PPR HICOM Shah Alam
Person in charges	Building manager	Building Manager	Technician Supervisor
Scope of work	Cleaning services	Cleaning services	Cleaning services
	Landscaping services	Landscaping services	Landscaping services
	Pest-control services	Security services	Pest-control services
	Security services	Lift services	Security services
	Lift services		Lift services
Policy, standard or guideline	No	No	No
Lift contractor	Dover Elevator	EITA Elevator	Dong Yang Elevator
Problem faced	Vandalism	Cost of Maintenance	Cost of Maintenance
Challenges faced	No outsource contractor	Mentality of residents	Mentality of residents

Source: Authors (2024)

The interviews conducted with individuals in charge of the management operations at each PPR building, including building managers from PPR Lembah Subang 2 and PPR Taman Putra Damai and a technician supervisor from PPR HICOM Shah Alam. The selected interviewees oversaw various aspects of building maintenance, including the vertical transportation systems. The interview questions were structure to gather insights into the current maintenance operations, the scope of work, and the challenges faced by the management teams in maintaining the lifts. The questions covered the frequency of maintenance activities in daily, weekly, monthly and annually of maintenance scope. Additionally, the interviewees asked about the procedures for addressing maintenance issues, whether they had access to contractors for lift repairs, and how they handled resident complaints or safety concerns.

Key Findings from the Interviews

Lack of Policies and Guidelines: All three (3) selected PPR buildings reported the absence of formal policies, standards, or guidelines for lift maintenance, which contributed to inconsistent maintenance practices and difficulties in managing the operation effectively.

Challenges in Maintenance Funding: The management teams at PPR Taman Putra Damai and PPR HICOM Shah Alam mentioned about cost relate issues as a significant challenge in maintaining lifts. Inadequate funds hinder the ability to perform regular repairs and ensure proper functioning.

Resident Mentality: A recurring challenge mentioned in the interviews was the residents' mentality, particularly their reluctance to pay maintenance fees. This issue was mentioned at both PPR Taman Putra Damai and PPR HICOM Shah Alam, where a lack of payment of maintenance fees.

Vandalism: At PPR Lembah Subang 2, the management team reported that vandalism was a significant problem, contributing to the frequent breakdowns of lifts and the need for additional repairs.

Contractor Availability: While contractors for lift maintenance are available at all three (3) residential buildings, the maintenance staff lacks specialised expertise. These results in delays and inefficiencies when addressing complex lift issues.

The interviews also revealed that while the management teams have regular maintenance routines, they face significant resource allocation, funding, and skilled labour challenges. Many respondents highlighted the need for external contractors to supplement internal maintenance teams but faced challenges securing qualified personnel or external contractors.

FINDINGS AND CONCLUSION

The research on vertical transportation maintenance in high-rise adorable residential buildings reveals several critical issues affecting the effectiveness of these systems. The analysis, which combines questionnaire data and interviews from three (3) PPR residential buildings in the Klang Valley, identifies key areas for improvement in safety, comfort, performance, complexity and operational efficiency.

Firstly, safety concerns were highlight, with moderate satisfaction levels across all sites regarding emergency lighting, CCTV security, and elevator functionality. The relatively lower satisfaction with CCTV systems suggests the need for improved security measures. Additionally, insufficient maintenance funding, caused by residents' reluctance to pay maintenance fees, delays repairs and compromises safety. Comfort issues, particularly overcrowding and unpleasant odours, were also prevalent, pointing to the need for more proactive maintenance practices and regular inspections. Performance factors, including energy efficiency, safety mechanisms, and operational speed, were generally satisfactory but marred by operational inefficiencies due to delayed or inadequate maintenance and a shortage of skilled technicians.

Another challenge was maintaining lift systems, which involved complexity, including issues with workmanship and high-tech components. Maintenance staff's lack of specialised knowledge often leads to delays and suboptimal repairs. The findings suggest that investing in maintenance personnel's training and using high-quality components can help reduce these issues. Additionally, operational effectiveness was hinder by insufficient maintenance, with response time and travel time being key areas for improvement.

The interviews further revealed that the absence of formal maintenance policies and guidelines at all three (3) PPR residential buildings contributes to inconsistent practices. Cost-related challenges and residents' reluctance to pay maintenance fees were significant obstacles to effective maintenance operations. Moreover, vandalism at one (1) PPR residential buildings and the lack of specialised contractors at all three (3) PPR residential buildings compounded these issues.

In conclusion, to improve vertical transportation maintenance in these residential buildings, formal policies and guidelines must be developed to standardize maintenance practices. Addressing funding issues, mainly through better enforcement of maintenance fee payments, will ensure that essential repairs and upgrades are complete promptly. It is crucial to educate residents on the importance of maintenance payments and their role in maintaining the building's safety. Furthermore, the recruitment and training of skilled technicians, along with the use of high-quality components and regular cleaning services, will enhance lift systems' comfort and performance. By implementing these measures, building management can improve vertical transportation systems' safety, comfort, and operational efficiency, benefiting all stakeholders.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Calvin Rico Satap Anak Sumping, a PhD student at the Faculty of Built Environment, Universiti Teknologi MARA (UiTM), Shah Alam, Selangor, Malaysia, carried out the research, wrote and revised the manuscript. Mohamad Ridzuan bin Yahya conceptualised the central research idea and provided the theoretical framework. Both Calvin Rico Satap Anak Sumping and Mohamad Ridzuan bin Yahya jointly designed the study and supervised its progress. Mohamad Ridzuan bin Yahya also led the critical review process, provided major revisions and approved the final submission. Nur Amirah Binti Abd. Samad reviewed and approved the final version of the manuscript.

REFERENCES

- Aliyu, A. A., Funtua, H. A., Mammadi, A., Bukar, B. G., & Abubakar, M. M. (2015). Problems associated with elevators in high-rise commercial buildings in North-Western state capitals of Nigeria. *Journal of Energy Technologies and Policy*, 5(12), 62–69. <http://www.iiste.org/Journals/index.php/JETP/article/view/27256>
- Chen, J. Y., Yan, Z. F., & Fan, R. (2023). Elements of the core area transport system oriented to station–city integration. *Computers and Electrical Engineering*, 110, 108842. <http://doi.org/10.1016/j.compeleceng.2023.108842>
- Dahal, R. C., & Dahal, K. R. (2020). A review on problems of the public building maintenance works with special reference to Nepal. *American Journal of Construction and Building Materials*, 4(2), 39–50. <http://doi.org/10.11648/j.ajcbm.20200402.12>
- Dhillon, B. S. (2002). *Engineering maintenance: A modern approach*. CRC Press. <http://doi.org/10.1201/9781420031843>
- Godwin, T. (2023). Vertical transportation lift capacity and operating policy planning for low-rise buildings with circulatory passengers. *ResearchSquare*. <http://doi.org/10.21203/rs.3.rs-3034899/v1>

- Isnaini Janipha, N. A., Syed Alwee, S. N. A., Mohd Ariff, R., & Ismail, F. (2018). Maintenance and safety practices of escalator in commercial buildings. *IOP Conference Series: Earth and Environmental Science*, 117, 012042. <http://doi.org/10.1088/1755-1315/117/1/012042>
- Kirui, G. (2024). Enhancing police operations: The impact of CCTV in monitoring, incident response, and crime investigation in Nairobi City County, Kenya. *International Journal of Scientific Research and Management*, 12(5), 1823–1834. <http://doi.org/10.18535/ijstrm/v12i05.sh01>
- Lateef, O. A. (2009). Building maintenance management in Malaysia. *Journal of Building Appraisal*, 4(3), 207–214. <http://doi.org/10.1057/jba.2008.27>
- Somasekaran, S. (2024). Enhancing user experience in elevator service: A field study. *Journal of Xidian University*, 18(4), 55–65. <http://doi.org/10.5281/zenodo.10924877>
- Zawawi, E. M. A., Kamaruzzaman, S. N., Ali, A. S., & Sulaiman, R. (2010). Assessment of building maintenance management in Malaysia: Resolving using a solution diagram. *Journal of Retail & Leisure Property*, 9(4), 349–356. <http://doi.org/10.1057/rlp.2010.16>



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