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A STUDY OF MAINTENANCE COMPETENCIES IN AIRPORT BUILDING FACILITIES

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Abstract

Airports function as global gateways and carry millions of people and tons of cargo each day. Therefore, maintaining and keeping them running is crucial. Thus, this study highlights the significant issues of insufficient maintenance and poor work quality in the airport building facilities, focusing on Kuala Lumpur International Airport (KLIA). Hence, these issues lead to inefficiencies in operations, safety concerns, and reduced passenger comfort, emphasising the importance of effective airport maintenance systems. This research aims to identify essential maintenance competencies, analyse maintenance employees' challenges, and make recommendations to enhance maintenance practices at KLIA. The data collection method involves collecting both primary and secondary data. Primary data is obtained through qualitative interviews with the KLIA building services department and related maintenance employees. These interviews employed both in-depth and semi-structured methods to ensure comprehensive data collection. Secondary data consists of information from existing papers, manuals, procedures, reports, and standards related to airport maintenance. The data collected from these interviews are systematically analysed to identify common issues as well as opportunities for improvement. This method ensures that the results are based on real-world experiences. Consequently, the analysis defines significant problems among KLIA maintenance employees, including skill gaps, challenges towards emerging technology, high reported costs, and inadequate training. Thus, this study implies that using new technology, preventive maintenance approaches, and providing regular training may considerably increase maintenance efficiency, safety, and passenger comfort in airport building facilities.

Keywords: Maintenance competencies, Airport building facilities, Kuala Lumpur International Airport (KLIA), Preventive maintenance, Qualitative interviews

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INTRODUCTION

The condition of a structure tends to deteriorate over time. Hence, consistent maintenance emerges as a prudent and effective strategy for safeguarding the structure against costly replacements and extending its lifespan. Thus, several key factors influence the decision for maintenance, including cost, age, property condition, resource availability, urgency, current and future use, and societal considerations (Wiggins, 2020). In particular, maintenance is a vital aspect that contributes to the efficient operation of facilities, equipment, and buildings, as Reksoprodjo et al. (2022) highlighted. According to Wiggins (2020), maintenance is conceptually framed as a composite of technical and administrative measures, encompassing supervision, directed at maintaining an object in its designated operational state or reinstating it to such condition. Consequently, maintenance is divided into two principal categories: Planned Preventive Maintenance (PPM) and reactive maintenance. Initially, PPM is methodically scheduled and implemented with a proactive, controlled, and documented approach. It comprises identifying minor flaws based on the condition of the equipment, allowing for proactive replacements to prevent severe issues from occurring. Thus, the objective is to keep the premises in good condition. On the other hand, unplanned or reactive maintenance includes breakdowns, accidents, corrections, and emergency types of methods. It is usually implemented by issues like vandalism, brutalisation, or a general lack of regular maintenance.

However, in Malaysia, there are several main maintenance management issues, such as low service quality (Nizam Kamaruzzaman et al., 2010; Au-Yong et al., 2014). Furthermore, according to Au-Yong et al. (2019), two other significant maintenance issues have been documented in five and three documents. There is a lack of awareness of the importance of maintenance and high maintenance costs. Other than that, the frequent finding of maintenance schedules that fail to perform on-time results in maintenance being carried out unintentionally. This issue only resulted in wasting money on maintenance and making maintenance less effective (Reksoprodjo et al., 2022). At the same time, Hauashdh et al. (2020) asserted that building maintenance issues were categorised based on their characteristics and phases. Therefore, four distinct categories of issues have emerged. Firstly, challenges arise from inadequate management of maintenance procedures, teamwork, quality, and maintenance strategy. Secondly, there is a failure to leverage technology for communication and information, particularly during the building design phase or maintenance process. Thirdly, financial problems have surfaced, encompassing challenges in managing spending costs and allocating funds effectively to achieve maintenance objectives. Lastly, human resource problems persist, encompassing issues related to workers' competence and job performance in the realm of maintenance.

Various issues highlight the importance of addressing the structural and financial aspects and the human and procedural elements within the broader context of facility management. For that reason, competencies play a vital role. The definition of competencies refers to individual characteristics such as motives, traits, self-concepts, attitudes, values, content knowledge, and cognitive or behaviour. These observable and reliable traits distinguish between excellent and average employees and between efficient and inefficient employees (Spencer et al., 1993; Wong, 2020). Meanwhile, Parry (1996) and Wong (2020) mentioned that competencies represent interconnected knowledge, abilities, and attitudes essential to an individual's job responsibilities and roles. They are related to job performance and can be improved through training and education. Additionally, Draganidis et al. (2006) and Wong (2020) explained that competencies involve direct and indirect skills and behaviours, enabling individuals to execute assigned tasks or responsibilities effectively.

A systematic approach to maintenance becomes critical given Malaysia's complex landscape of facility management difficulties and the relevance of competencies. In the case of maintenance (i.e., PPM), various tasks, including preventive measures like painting and boiler servicing, corrective actions such as roof replacement every 15 years, and annual inspections, are conducted. These inspections assess the building's condition, the building services, and the surrounding area. This method allows for the oversight and management of whether the tasks outlined in the long-term plan are genuinely necessary. That is, whether any work might need to be pushed due to unexpected deterioration or failure and identifying items not initially considered in the long-term plan (Wiggins, 2020).

The perspective of maintenance could be expanded in the context of airport infrastructure. As defined by Waris, Adisasmita and Ramli (2019), an airport functions more than just a place to land and take off; it also serves various other purposes. This includes passenger and cargo handling, intermodal transit, and different support facilities. The main functions of an airport are categorised into two types: aeronautical and non-aeronautical. Both of them require different sorts of appliances. Aeronautical facilities can be characterised by technical complexity, encompassing instruments like landing systems, air traffic management systems, runways, taxiways, and aircraft stands. On the other hand, non-aeronautical facilities are diverse, including hotels, restaurants, shops, and parking lots (Tarudin et al., 2020). Airport facilities serve diverse users and necessitate specific amenities for optimal functioning. The two primary types of airport components are landside and airside. The airside manages aircraft operations, while the landside oversees passenger operations. The planning and design of airport components guarantee seamless connections between relevant activities, facilitating precise transit from one location to another (Hamid et al., 2021). The quality of facility services plays a vital role in determining the overall

quality of airport services. This refers to the various facilities that serve passengers, from getting checked in at the airport to passing through security checks and boarding. This also includes amenities utilised for various activities, such as restrooms, lavatory facilities, and participating in other airport-provided activities (Mainardes et al., 2021; Ma & Ma, 2022).

Hitherto, Malaysia had a total of 58 airports, 37 of which had regular scheduled passenger services. Among all the airports, 36 airports are located in East Malaysia, while 22 airports are in Peninsular Malaysia (Kok et al., 2023). In Malaysia, two different organisations are responsible for the construction and operation of the airports. The government oversees the development of airport infrastructure, while Malaysia Airports Holdings Berhad (MAHB), a private company, currently manages airport operations and maintenance. Except for Kerteh Airport in Terengganu and Senai Airport in Johor, all airports in Malaysia are operated and managed by MAHB (Hamid et al., 2021). Prior to the establishment of MAHB, Malaysia Airport Berhad (MAB) was formed in 1992 to serve as the airport operator. Initially, MAB was granted a concession to manage and operate 33 airports with scheduled traffic for 30 years. In November 1999, MAB transformed into a public limited company, now known as MAHB. In 2019, MAHB extended its operating contracts for 35 years, valid until 2069. MAHB's primary business activities are divided into five key categories: airport services, duty-free hotels, agricultural and horticulture, and project and repair maintenance (Kok et al., 2023). The objectives of this study are twofold: (i) to explore the maintenance routine in airport building facilities and (ii) to investigate the challenges associated with maintenance work.

RESEARCH METHODOLOGY

The data was collected by in-depth, semi-structured interviews. As defined by Fox (2000), semi-structured interviews use open-ended questions to define the topic being studied and allow the interviewer and interviewee to gain more insight into specific issues. Additionally, in-depth interviews come with several advantages:

- Allow for comprehensive data collection from the interviewees.
- This will allow researchers to study respondents' responses more thoroughly, delivering a deeper understanding of their experiences than a more organised interview.
- Can analyse the experiences of different interviewees chosen to examine a variety of perspectives.
- Allow the interviewees to "speak for themselves," increasing the validity of the data.

This strategy enables researchers to oversee more complicated issues related to research, resulting in higher validity and reliability in the findings (Aberdeen, 2013). Therefore, the study collected data using a semi-structured questionnaire that served as the interviewer's guideline. Specific questions were initially established to guide the interview and fulfil the study objectives. The interviews took around 40 to 50 minutes. Throughout the interviews, the researcher audio-recorded the whole discussion with their permission to help study the collected data. Respondents were allowed to express their thoughts on the questions raised during the interview. Overall, the interviews were enjoyable and interesting to comprehend.

ANALYSIS

Respondents' profile

Table 1 summarises brief profiles of the interviewees. The data collected state that four interviewees were between the ages of 21 and 30, four were between the ages of 31 and 40, and two was between the ages of 41 and 50.

Table 1: Profile of the interviewees

Age Group	Number of Respondent	Percentage (%)
21 – 30	4	40
31 – 40	4	40
41 – 50	2	20
Total Number of Respondents	10	100

All of the participants were male. One was responsible for maintaining the airport's seating, plumbing, signage, and painting. Another participant was a technician who maintained the electrical works and Air Handling Unit (AHU). Another participant was a baggage service technician for MAHB. Lastly, two participants operated in building services, primarily operating and maintenance for MAHB Sepang, mainly at Kuala Lumpur International Airport 1 (KLIA 1).

Normal Maintenance Routine

This section provides an in-depth analysis of routine maintenance operations in KLIA based on perspectives from individuals directly involved in those operations. By evaluating the viewpoints of respondents working in airport building and maintenance, the researcher gains a better knowledge of the procedures being utilised. Each respondent provides an individual perspective to the researcher's specific analysis of routine maintenance practices. It helps to develop our understanding of standard procedures and identify improvement opportunities. Perspectives from several maintenance professionals and specialists allow the researcher to identify throughout procedures and better understand the standard of maintenance of building facilities in KLIA.

The maintenance technicians focused on monitoring two particular conveyor systems. The first one is the cross belt and the tilt tray machine. Both of which can manage up to 4,000 bags per hour. Therefore, this huge capacity requires proper and regular maintenance procedures. Additionally, they use Programmable Logic Controllers (PLC) for maintenance operations. PLCs help automate control operations, increase the efficiency of maintenance work, and reduce the risk of errors.

The different viewpoints of maintenance experts and specialists lead to a better understanding of maintenance routine procedures. The answers include understanding systematic approaches, PPM plans, the implementation of advanced technology, and the significance of asset replacement for maintaining airport facilities operable and safe, as summarised in Table 2.

Table *2:* Key findings and emerging discoveries in maintenance strategies, highlighting the role of preventive maintenance, modern technologies, and effective resource management.

Finding	Description	Emerging Discoveries
Viewpoints of Maintenance Experts	Different perspectives enhance understanding of maintenance procedures.	Emphasis on systematic approaches, preventative maintenance, and the role of advanced technologies in keeping airport facilities safe.
Planned Preventative Maintenance (PPM)	PPM is a key strategy for KLIA, focusing on scheduled inspections to prevent major issues.	Proactive PPM helps in detecting minor issues early, ensuring optimal facility conditions and prolonging facility lifespan.
Combination of Maintenance Strategies	A mix of short-term and long-term maintenance strategies is used.	PPM and annual maintenance activities are complemented by corrective and breakdown maintenance, ensuring timely response (24-48 hours) to issues.
PPM's Role in Budgeting	PPM is beneficial for long-term budget planning and resource allocation.	Helps in forecasting maintenance needs, ensuring smooth operation and resource efficiency.
Use of Modern Technologies	Systems like BMS and SCADA play critical roles in maintenance operations.	BMS improves energy efficiency, while SCADA monitors and controls

Finding	Description	Emerging Discoveries
		systems in real-time, boosting response time and reducing human errors.
Asset Replacement	Regular asset replacement, particularly for critical components like lighting and firefighting systems, is a key practice.	Scheduled asset replacement (every 5 years) minimizes risks and ensures that facilities remain functional and safe.

Firstly, the researcher acknowledged that PPM is a crucial method used within the KLIA's maintenance routine. It encompasses scheduled inspections and planned maintenance operations to prevent machinery issues and ensure smooth operation. According to Wiggins (2020), the PPM method focuses on detecting and solving minor problems before they become major ones. Notably, by eliminating those little problems early on, PPM helps to keep the building in excellent condition, thus ensuring that everything functions properly and remains in optimum condition for everyone who uses the area. Therefore, this proactive strategy helps with the early detection and resolution of potential issues in the future, minimising delays and increasing the life of the facilities.

Next, the findings reveal the combination of short-term and long-term maintenance strategies. Long-term planning through PPM and yearly maintenance activities is complemented by short-term corrective and breakdown maintenance. Major issues are addressed within 48 hours, while minor issues are fixed within 24 hours, thus ensuring full consideration of maintenance obligations. As stated by Wiggins (2020), the PPM method is also beneficial for developing a long-term maintenance budget plan. Furthermore, it assists with allocating resources effectively by assessing future requirements and ensuring smooth operations throughout time.

The analysis emphasises the importance of modern technologies like BMS and SCADA systems in maintenance operations. According to Rey-Hernández et al. (2020), the use of BMS is essential for maintaining and continually improving interior areas and significantly minimising the cost of electricity. Meanwhile, as stated by Basu and Debnath (2019), SCADA frequently functions as a main controller, monitoring set points, overseeing the system and coordinating operations immediately. These systems provide real-time data and control, improving the ability to identify and manage problems quickly. In addition, using PLCs facilitates management operations, boosting productivity and lowering the possibility of human mistakes. Additionally, regular asset replacement, particularly for essential components like lighting, AHUs, and firefighting systems, is an essential routine. Scheduled asset replacement every five years ensures the facilities are presentable and functional, significantly lowering the risk of serious accidents.

These findings emphasise the need for deep and well-planned maintenance processes to ensure the effectiveness, smooth operation, and safety of airport building infrastructure.

Challenges In Maintenance Work

Throughout this data analysis phase, the researcher focuses on the challenges encountered by maintenance workers at KLIA to ensure that the workers explain valuable experience in the parts of their jobs. By considering the opinions of respondents participating in the maintenance processes, the researcher understands the challenges related to their productivity and effectiveness. Each of the responses offers an individual perspective, which contributes to an entire assessment of the multiple issues faced by the maintenance personnel. The different perspectives affect the discussion on these topics, allowing the researcher to find common themes, identify various points of view, and better understand the challenges that KLIA maintenance workers encounter.

The research study highlights the complex nature of maintenance work in such a challenging and dynamic workplace by investigating their experiences in detail. The findings reveal significant challenges to productivity and effectiveness, emphasising the importance of specialised skills, safety regulations, cooperation among stakeholders, and the continuous ability to adapt to shifting circumstances in Table 3.

Table 3: Major findings and emerging discoveries related to the challenges faced by KLIA's maintenance operations, emphasising the need for specialised skills, safety measures, coordination, and efficient resource management.

Finding	Description	Emerging Discoveries
Complex Nature of Maintenance Work	Maintenance at KLIA involves handling fragile materials, safety risks, and adapting to changing circumstances.	Maintenance workers require diverse, specialized skills, particularly in handling materials like glass, and must adapt to various scenarios.
Challenges with Fragile Materials	Working with fragile materials like glass in terminal buildings requires precision and attention to detail.	Damage to glass surfaces can pose safety risks to workers and visitors, demanding specialized skills to avoid accidents.
Working at Heights	Maintenance of high structures like lighting systems and towers involves significant safety risks.	Safety protocols, training, and equipment like belts and scaffolding are essential to prevent accidents such as falls and electrical shocks.
Safety Protocols	Ensuring worker safety in high-risk environments is	Adherence to safety standards, proper training, and use of

	critical to prevent injuries and fatalities.	appropriate equipment are crucial for maintaining safety and productivity.
Coordination with Stakeholders	Effective communication and coordination with stakeholders are vital for maintenance planning and operations.	Coordinating system shutdowns and minimizing disruptions require approval and careful planning to ensure smooth airport operations.
Aging Equipment and Systems	Aging equipment demands frequent inspections and repairs, increasing maintenance workload.	Proactive management and resource allocation are required to balance operational efficiency with the limitations of outdated equipment.
Conveyor System Maintenance	Maintaining KLIA's 42 km conveyor system involves complex logistical planning and team management.	Repairing damaged conveyors can take hours, and effective communication among the large maintenance team is crucial for operational efficiency.
Role of Modern Technologies	Technological advancements, such as computerized systems for data management, can improve maintenance efficiency.	Stakeholders depend on technology to manage maintenance data, but challenges in implementation slow down decision-making processes.

One of the challenges is working with fragile materials like glass. KLIA's use of glass in terminal buildings, windows, and landscaping necessitates precise and skilled handling to prevent damage. Maintenance tasks involving glass, such as repairing broken panels, require careful attention and skills to detail to avoid further issues, including safety hazards for maintenance employees and visitors. Additionally, maintenance procedures vary significantly depending on the specific issue and place, requiring a diverse set of skills from the crew.

Furthermore, significant challenges are associated with working at heights. Maintenance tasks on high structures, such as lighting systems and communication towers, require strict adherence to safety protocols and the use of specialised equipment like belts and scaffolding. As stated by Hauashdh et al. (2022), the most common risks during executing maintenance work include falling from high places, electrical shock, and dealing with flammable substances. These incidents are normally caused by a lack of training, inadequate equipment, or poor safety precautions. Some maintenance personnel may not have had adequate training in safety measures, correct equipment operation, or managing dangerous chemicals. Additionally, lowering expenses, rushing to finish work, inadequate safety standards, and the use of defective equipment, like damaged stairs or electrical tools, can increase the possibility of injuries and incidents. Thus, ensuring worker safety while performing these tasks is

paramount, and the complexity of operations at KLIA necessitates a versatile approach to maintenance procedures, whether for routine inspections or emergency repairs.

According to Simeon and Aliu (2023), various factors can influence the efficient execution of safety standards, including organisational culture, commitment from managers, staff training, availability of resources, advancements in technology regulations, and the work environment. Accordingly, maintaining these standards is essential for ensuring the safety of employees and visitors. Moreover, implementing these safety standards is vital to avoid any incidents, fatalities, and injuries, enhance optimism among staff members, improve productivity, and lower the expenses related to workplace incidences.

In addition, dealing with various stakeholders presents another major challenge. Coordinating system shutdowns for maintenance requires approval from relevant parties and careful planning to minimise disruptions. Effective stakeholder communication and scheduling are crucial to maintaining smooth airport operations during maintenance activities. As per Zhao et al. (2022) and Hauashdh et al. (2020), a collaboration involving several building facilities maintenance stakeholders involves a considerable amount of data that is sometimes unorganised and difficult to manage. This slows down the decision-making process for maintenance activities. Nevertheless, Gao and Pishdad-Bozorgi (2019) also stated that some maintenance organisations are still trying to fully implement technology for good data management, which could enhance connectivity while offering beneficial perspectives. Therefore, they depend on manuals with complicated procedures, increasing the risk of human mistakes and reducing maintenance efficiency.

Other than that, as equipment deteriorates over time, it demands more frequent inspections and repairs. This increases the maintenance workload and necessitates a balance between maintaining operational efficiency and addressing the limitations of outdated equipment. The need for regular maintenance of ageing systems underscores the significance of proactive management and resource allocation.

Apart from that, maintaining KLIA's extensive 42 km conveyor system presents significant challenges, including managing the departure and arrival conveyors, where repairing a damaged conveyor can take up to five hours and requires the availability of proper tools and equipment. Additionally, effective communication is crucial among the large maintenance team, particularly in the luggage department, which consists of 130 employees, with 20 assigned to each shift. As mentioned by Rahman and Rahman (2023), the authorities should emphasise improving airport quality by enhancing luggage handling capacity and speeding up the cargo process. This can be achieved by utilising efficient machinery, executing strict assessments, and establishing computerised

systems for data management. Therefore, it is crucial to ensure coordinated and efficient maintenance operations. The scale and complexity of the conveyor system highlight the need for robust logistical planning and team management.

Addressing these challenges requires specialised skills, adherence to safety protocols, proactive management, and efficient stakeholder coordination. Nevertheless, the insights gained from this research contribute to a deeper understanding of the critical role maintenance workers play in ensuring airport facilities' safety, comfort, and operational efficiency.

DISCUSSION

The research outcomes of the study on maintenance routine in airport building facilities, with a particular focus on KLIA in Sepang, Malaysia, provide significant insights into current maintenance approaches for operational efficiency. Accordingly, this study provides an extensive evaluation of the current state of maintenance operations. It highlights several important points that require monitoring and improvements.

Firstly, one of the key findings in this study is the normal routine of maintenance activities. The study indicates that KLIA's maintenance procedures primarily operate as reactive rather than proactive, leading to inefficiencies and increased expenditures. Furthermore, a significant concern has been identified: a knowledge and competence gap among maintenance workers. Furthermore, employees' lack of proper training and skills limits their ability to effectively conduct maintenance tasks, indirectly affecting work quality and causing safety issues. In addition, this study also analyses the challenges that maintenance employees encounter, including the high expenses of maintenance operations, the inability to perform well in implementing new technologies, and insufficient training programmes. These challenges significantly impact both the efficiency and safety of airport operations, thus leading to increasing stress and work frustration among maintenance employees. Also, hesitancy to use new technology, commonly due to a lack of training and understanding, contributes to these issues.

Finally, the findings of this study reveal the need for improvements in KLIA's maintenance approaches. Thus, by emphasising improved training, adopting new technology, and implementing preventative maintenance measures, the airport may significantly enhance its operational efficiency while providing a safer and more comfortable environment for workers and visitors.

CONCLUSION

In conclusion, this study underscores the critical importance of effective maintenance practices at KLIA, emphasising how they impact operational efficiency, safety, and passenger comfort. The research reveals significant issues stemming from insufficient maintenance and poor work quality, primarily due to

reactive maintenance strategies and skill gaps among employees. These challenges lead to operational inefficiencies, increased costs, and safety concerns, highlighting the urgent need for improvement. In addition, the key findings indicate that practical knowledge and job-specific training are essential for maintenance staff to adapt to new technologies and perform their roles effectively. The study advocates for proactive training programmes and preventive maintenance approaches to address identified gaps, such as the reliance on ageing infrastructure and the complexities of communication among stakeholders. Moreover, integrating BMS with maintenance operations can enhance monitoring and management, thereby minimising downtimes and improving safety protocols. The study further suggests that investing in continuous training and adopting new technologies will elevate maintenance competencies and significantly enhance the passenger experience and overall operational efficiency. Ultimately, by prioritising these areas, KLIA can improve its maintenance strategies, ensuring a safer, more efficient environment for staff and travellers. Nevertheless, this research contributes valuable insights into the critical role of maintenance practices in airport operations, setting a foundation for future enhancements that benefit all airport stakeholders.

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