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Master of Business Administration (MBA)



**The Impact of Strategic Asset Management Practices on Operational
Performance of Baggage Handling Systems at King Abdulaziz
International Airport, Jeddah.**

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DECLARATION

I hereby declare that this dissertation entitled “The Impact of Strategic Asset Management Practices on the Operational Performance of Baggage Handling Systems at King Abdulaziz International Airport, Jeddah” is my original work and has been prepared by me under the supervision of Dr. Al-Faisal Abdulhamid Mohammed Hassan and Dr. Fayez Jarrad.

I confirm that this dissertation has not previously been submitted, either in whole or in part, to any university or academic institution for the award of any degree or qualification. All sources of information, theories, ideas, data, and previous research used in this dissertation have been appropriately acknowledged and referenced in accordance with accepted academic standards.

I also confirm that the data presented in this dissertation were collected and analyzed for the purposes of this study and that the research was conducted in accordance with ethical principles relating to voluntary participation, confidentiality, anonymity, and responsible academic practice.

DEDICATION

I dedicate this dissertation to my beloved family, whose unconditional love, patience, encouragement, and continuous support have been the foundation of my academic journey.

To my parents, who taught me the value of education, determination, and perseverance, and whose prayers and guidance have always inspired me to continue working toward my goals.

To my family members and loved ones, who supported me throughout the challenges of this research and provided me with the motivation and strength required to complete this work.

This dissertation is dedicated to all of you with my deepest love, gratitude, and appreciation.

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ABSTRACT

Background: In today's airports, effective management of physical, technological and human resources is more and more crucial for good operational performance, making strategic asset management a major concern. Baggage handling systems are one of the most important airport infrastructures because they impact passenger congestion, baggage delivery, aircraft turn-around time, operational delays and passenger satisfaction.

Objective: The present study aimed to investigate the effect of Strategic Asset Management practices on the operational performance of baggage handling system at King Abdulaziz International Airport at Jeddah, Saudi Arabia.

Methods: The method applied was quantitative based descriptive analytical design with cross sectional approach. The data was gathered from 44 valid respondents from all sectors of the baggage handling, maintenance, service management, asset management, information technology, supervision and managerial staff of the given category in the company, on a five-point Likert scale. Descriptive data analysis, Cronbach's alpha, Pearson correlation, simple linear regression and multiple linear regression were analyzed.

Findings: The questionnaire was nicely reliable, with a Cronbach's alpha coefficient of 0.964. The five Strategic Asset Management dimensions – Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation – were used at high or very high level. There were strong positive and statistically significant relationships between all dimensions with operational performance.

Conclusion: Strategic Asset Management practices have significant impact on the operational performance of the baggage handling systems. Preventive Maintenance was the most prominent direct contributor, while Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation were complementary and interconnected capabilities.

Recommendations: The study suggests increasing the strength of preventive and predictive maintenance; integration of digital monitoring with operational and maintenance management systems; creation of formal asset lifecycle plans; enhancement of technical training and management of spare parts; and introduction of reliability-based performance indicators.

The keywords: Strategic Asset Management, Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, Resource Allocation, Operational Performance, Baggage Handling Systems, King Abdulaziz International Airport.

الملخص باللغة العربية

الخلفية: أصبحت الإدارة الاستراتيجية للأصول ذات أهمية متزايدة في المطارات الحديثة، نظرًا لاعتماد الأداء التشغيلي على الإدارة الفعالة للأصول المادية والتكنولوجية والبشرية. وتُعد أنظمة مناولة الأمتعة من أهم البنى التحتية في المطارات، لما لها من تأثير مباشر في حركة المسافرين، وسرعة تسليم الأمتعة، وزمن دوران الطائرات، والتأخيرات التشغيلية، ورضا المسافرين.

الهدف: هدفت الدراسة إلى تحليل أثر ممارسات الإدارة الاستراتيجية للأصول في الأداء التشغيلي لأنظمة مناولة الأمتعة في مطار الملك عبدالعزيز الدولي بمدينة جدة.

المنهجية: اعتمدت الدراسة المنهج الكمي الوصفي التحليلي باستخدام تصميم مقطعي. جُمعت البيانات من خلال استبيان منظم قائم على مقياس ليكرث الخماسي، وبلغ عدد الاستجابات الصحيحة 44 استجابة من موظفين يعملون في مناولة الأمتعة، والصيانة، وإدارة الخدمات، وإدارة الأصول، وتقنية المعلومات، والإشراف، والوظائف الإدارية المرتبطة بالنظام. واستُخدمت الإحصاءات الوصفية، ومعامل ألفا كرو نباخ، وارتباط بيرسون، والانحدار الخطي البسيط والمتعدد.

النتائج: أظهرت أداة الدراسة درجة ممتازة من الثبات، حيث بلغ معامل ألفا كرو نباخ الكلي 0.964. كما طُبقت أبعاد الإدارة الاستراتيجية للأصول الخمسة، وهي الصيانة الوقائية، والصيانة التنبؤية، وتخطيط دورة حياة الأصول، وأنظمة المراقبة الرقمية، وتخصيص الموارد، بمستويات مرتفعة أو مرتفعة جدًا. وأظهرت النتائج وجود علاقات إيجابية قوية ودالة إحصائيًا بين جميع الأبعاد والأداء التشغيلي. كما فسّر نموذج الانحدار المتعدد 71.8% من التباين في الأداء التشغيلي، وكانت الصيانة الوقائية البعد الوحيد الذي احتفظ بتأثير مستقل دال إحصائيًا عند إدخال جميع المتغيرات في النموذج.

الاستنتاج: خلصت الدراسة إلى أن ممارسات الإدارة الاستراتيجية للأصول تسهم بصورة دالة في تحسين الأداء التشغيلي لأنظمة مناولة الأمتعة. وكانت الصيانة الوقائية أقوى مساهم مباشر، بينما عملت الصيانة التنبؤية، وتخطيط دورة حياة الأصول، وأنظمة المراقبة الرقمية، وتخصيص الموارد بوصفها قدرات مترابطة ومتكاملة.

التوصيات: أوصت الدراسة بتعزيز الصيانة الوقائية والتنبؤية، وربط أنظمة المراقبة الرقمية بأنظمة التشغيل والصيانة، ووضع خطط رسمية لدورة حياة الأصول، وتطوير التدريب الفني، وتحسين إدارة قطع الغيار، وتطبيق مؤشرات أداء تركز على موثوقية النظام.

الكلمات المفتاحية: الإدارة الاستراتيجية للأصول؛ الصيانة الوقائية؛ الصيانة التنبؤية؛ تخطيط دورة حياة الأصول؛ أنظمة المراقبة الرقمية؛ تخصيص الموارد؛ الأداء التشغيلي؛ أنظمة مناولة الأمتعة؛ مطار الملك عبدالعزيز الدولي.

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CHAPTER ONE

1. INTRODUCTION

Airports use a variety of technologies designed to optimize passenger flow, aircraft turnaround, and service provision. Passenger movement and aircraft turnaround depend on the synergistic functioning of various technical systems. Any malfunctioning of a component system can lead to delays in flights, movement of passengers, and can paralyze the functioning of the airport (Rubio-Andrada et al., 2023; Sun et al., 2024).

Of the multiple operational systems, the most important, by far, is the baggage handling system (BHS). They are responsible for the movement, sorting, screening and delivery of passenger baggage, and for taking baggage to the aircraft. Any infrastructural failure in the BHS has the potential to cause delays in the processing of passengers, increased aircraft turnaround time, and a reduction in passenger satisfaction (National Academies of Sciences, Engineering, and Medicine, 2023).

Reliability of systems at the airport can be attributed to the effective management of the technological and operational systems over their life cycle. In complex environments, the reliability of systems has been improved and operational downtime reduced using advanced strategic asset management techniques, integrated preventive maintenance, predictive maintenance, life cycle management, and resource management. (Oukacha et al., 2025; Gürsel et al., 2023).

Due to its significance in examining operational challenges across airports in the Middle East, King Abdulaziz International Airport (KAIA) in Jeddah, handles high traffic volumes coupled with complicated logistical scenarios, serving as the main gateway for numerous pilgrims traversing to Makkah annually. The operational pressure on the baggage handling system (BHS) is substantial, necessitating reliability and efficiency. (General Authority of Civil Aviation, 2023).

There is a dearth of literature concerning the operational dimension of the systems and the impact of strategic asset management on the operational performance of the BHS in Saudi airports. Hence, this study seeks to analyze the strategic asset management and operational performance of BHS at King Abdulaziz International Airport in Jeddah. (General Authority of Civil Aviation, 2023).

1.1. Background of the Study

Air travel is currently one of the largest enablers of economic growth, international commerce and global tourism. The airports are no longer just transport hubs but are becoming an integrated, high-tech operational ecosystem that requires intelligent infrastructure, cutting-edge technology and effective operational management to ensure the smooth transportation of passengers and cargo. Air travel has been growing rapidly, as has the expectations of passengers, and the capacity of airports has expanded, making airport operations much more complex. In this regard, airport operators around the world have started to focus on optimizing their operations by operating critical infrastructure assets efficiently (Airports Council International [ACI], 2023; Sun et al., 2024).

Baggage Handling System (BHS) is one of the most vital and technically complex infrastructures at the airports among the various operational subsystems of an airport. Baggage handling system involves many interrelated activities like checking-in, screening, sorting, moving, storing, loading and loading onto aircraft. Because every traveler's trip relies on the reliability of the baggage system's delivery, the functionality of these systems affects passenger satisfaction, airline on-time performance, airport productivity and overall service quality. The loss or delay of a bag can cause delays, cost, and damage to an airport's reputation, as well as to its passengers and staff (National Academies of Sciences, Engineering, and Medicine, 2023; Rubio-Andrada et al., 2023).

Nowadays, baggage handling systems are made up of thousands of mechanical, electrical and digital components which are subject to heavy-duty operating conditions, all of which are connected together. They consist of conveyor belts, programmable logic controllers (PLC), barcode and RFID scanners, automated sorting machines, screening equipment, sensors and control software. The dependence of these subsystems results in a rapid propagation of failure throughout the entire baggage handling network and impact on the airport operations. This makes airport management's need for high system availability and operational reliability as a strategic priority (Rekiek, 2023; Oukacha et al., 2025).

To address these operational demands, strategic asset management has evolved into an asset management philosophy to achieve optimum value from physical assets throughout its lifecycle. Strategic asset management focuses not just on equipment maintenance, but also on planning, investing in assets, maintaining them, monitoring their performance, optimizing their life cycle, managing risks, and managing resources and their allocation. According to the international standard ISO 55000 (International Organization for Standardization [ISO], 2024), asset management is the coordinated activities of an organization carried out on assets to ensure the value is created through the balancing of asset performance, cost and risk throughout the asset life cycle.

Strategic asset management is gaining significance in industries with extensive infrastructure, like the aviation and energy sectors, but also in transportation and logistics. Airports spend billions of dollars on assets that need ongoing maintenance, enhancements and operating monitoring to ensure reliability of service levels. Strategic asset management can help airport operators minimize unwarranted equipment failures, prolong the life of an asset, optimize maintenance budgets, enhance operational availability, and facilitate future sustainability goals (Green et al., 2025; Gürsel et al., 2023).

The digitalization of technologies linked to Industry 4.0 is one of the greatest strides towards supporting strategic asset management. The advent of new technologies, such as Artificial Intelligence (AI), Internet of Things (IoT), digital twins, cloud computing, predictive analytics and real-time monitoring systems, has revolutionized the way maintenance is done and made it a more intelligent predictive maintenance system that can detect equipment degradation even before it fails. They enable airport managers to have real-time visibility on the operational processes and make proactive decisions based on the real-time asset performance data (Nasser et al., 2025; Marevac, 2025; Wandelt, 2025).

Airport strategy asset management has one of the most important and valuable aspects: predictive maintenance. Predictive maintenance differs from reactive maintenance, which is the maintenance approach that focuses on equipment failures after they happen, by leveraging sensor data, machine learning algorithms, and condition-monitoring technologies to predict equipment failures before they happen. This helps to avoid operating disruptions, lower maintenance expenses and increase the reliability of baggage handling operations. Likewise, preventive maintenance programmes remain important as they ensure that maintenance tasks are carried out regularly to avoid deterioration of equipment before the point of failure occurs (Jammal et al., 2025; Marevac, 2025; Oukacha et al., 2025).

The other key aspect of strategic asset management is lifecycle asset planning. Infrastructure assets need to be planned systematically from the acquisition phase to the operation, maintenance, modernization and eventual replacement. Lifecycle planning allows airport operators to maximize their asset investments and minimise overall asset ownership costs whilst operating assets for a long time and maintaining acceptable levels of performance. Lifecycle planning is supported by resource allocation, which helps to ensure that financial resources, skilled people, maintenance equipment, and technological

capabilities are deployed appropriately to achieve the operational goals (National Academies of Sciences, Engineering, and Medicine, 2023; Green et al., 2025).

Digital monitoring systems are also an integral part of the airport infrastructure management. Operational data from the various types of equipment used in the baggage system are continuously collected through their sensors and automated control systems, allowing managers to track the state of equipment, detect any operational irregularities and take any necessary corrective measures before any equipment failure occurs. Real-time monitoring boosts the speed of decision-making, increases the transparency of operations and generally strengthens the infrastructure's resilience (Belden, 2024; Oukacha et al., 2025).

In big international airports with high passenger flow, the significance of the baggage handling system has been more apparent. King Abdulaziz International Airport (KAIA) in Jeddah is one of the most bustling airports in the Middle East and is the main airport for millions of pilgrims who visit the city of Makkah each year for Hajj and Umrah. Apart from religious tourism, the airport is set to host more and more business travelers and tourists from across the world as part of Saudi Arabia's Vision 2030 to make the Kingdom a global logistics and aviation hub (General Authority of Civil Aviation, 2023; Nounou & Shaban, 2025).

Due to the surge in passenger movement at the KAA, its systems are under heavy operational strain. The airport must have a very high degree of operational efficiency, equipment reliability and service continuity to ensure that it is able to handle seasonality that occur during the Hajj and Umrah period. Therefore, strategic asset management is crucial for minimizing operational disruptions, reducing baggage delays, improving passenger satisfaction, and maintaining airport competitiveness (General Authority of Civil Aviation, 2023; Oukacha et al., 2025).

Saudi Vision 2030 also emphasizes the significance of investing in sustainable infrastructure and implementing smart technologies, operational excellence, and digital

transformation to improve airport infrastructure. The National Transport and Logistics Strategy focus on enhancing airport performance and the use of cutting-edge digital technologies that can help to increase efficiency and help support economic diversification. Strategic Asset Management can be closely associated with these national priorities as it offers systematic solutions for managing complex airport infrastructure and maximizing infrastructure performance (Kingdom of Saudi Arabia, 2023; Nasser et al., 2025).

Although a large number of international airports are interested in the digitalization and intelligent management of their infrastructure, there is still limited academic literature on practical application of strategic asset management for baggage handling systems in Middle Eastern airports. The previous studies have been either airport operational efficiency or maintenance strategy for manufacturing industry, or new technologies without analysing the integrated application of the strategic asset management practices on the performance of the baggage handling system. Additionally, the number of empirical studies carried out in airports in Saudi Arabia is still limited (Wandelt, 2025; Rafles & Sari, 2025; Putra et al., 2024).

Therefore, the aim of this research is to fill this knowledge gap by studying the effect of strategic asset management practices (preventive maintenance, predictive maintenance, asset lifecycle planning, digital monitoring systems and resource allocation) on the operational performance of the baggage handling system at King Abdulaziz International Airport, Jeddah. The results are anticipated to enhance the academic understanding and managerial practice by offering evidence-based recommendations for infrastructure optimization, operational excellence, and sustainable management of the airport.

1.2.Problem statement

In modern airports, one of the most important pieces of operational infrastructure is the BHS, as it impacts passenger flow, airplane turnaround time, and service reliability. Failures in baggage systems can lead to operational delays, and other issues, which can lead

to a significant impact in the operation of the airport and can hurt passenger satisfaction (National Academies of Sciences, Engineering, and Medicine, 2023). While several airports have adopted new technologies to enhance the efficiency of their baggage handling systems, there is still a lack of operational efficiency. Research indicates that the performance of a system's infrastructure is a function of the system's physical assets, including the lifecycle management, maintenance, and operational replacement strategies, as well as the management of the assets. (Oukacha et al, 2025).

In this study, the managerial issue being tackled is the scant empirical evidence regarding the strategic asset management practices, and how they affect the operational performance of baggage handling systems in Saudi airports. This study seeks to explain this relationship by looking into some practices such as preventive maintenance, predictive maintenance, lifecycle planning, digital monitoring, and resource allocation as they relate to the baggage handling systems of King Abdulaziz International Airport in Jeddah.

1.3.Research Objectives

1.3.1. General Objective

Analyze how strategic management of assets impacts the operational performance of the baggage handling systems in King Abdulaziz International Airport.

1.3.2. Specific Objectives

- 1- Establish the strategic asset management practices in use in the baggage handling systems at King Abdulaziz International Airport.
- 2- Evaluate the operational performance of the baggage handling systems in the areas of efficiency, reliability, reduction of delays, and quality of services.
- 3- Assess how the application of preventative maintenance impacts the performance of the baggage handling systems.

- 4- Assess the extent to which predictive maintenance and digital monitoring systems impact operational performance.
- 5- Assess the impact of lifecycle asset planning and the allocation of resources on the performance of the system.

1.4.Research Questions

- 1) What strategic asset management practices are implemented in the baggage handling systems at King Abdulaziz International Airport?
- 2) What is the current level of operational performance of baggage handling systems at the airport?
- 3) What is the effect of preventive maintenance on the operational performance of baggage handling systems?
- 4) What is the effect of predictive maintenance and digital monitoring on the operational performance of baggage handling systems at King Abdulaziz International Airport?
- 5) What is the impact of life's asset planning and resource distribution on the performance of baggage handling systems?

1.5.Research Hypotheses

1.5.1. Main Hypothesis

H0: Strategic asset management practices do not have an impact on the operational performance of the baggage handling systems at King Abdulaziz International Airport.

H1: Strategic asset management practices do have an impact on the operational performance of the baggage handling systems at King Abdulaziz International Airport.

1.5.2. Sub-Hypotheses

H01: Preventive maintenance practices have no impact on the operational performance of the baggage handling systems.

H02: Predictive maintenance practices have no impact on the operational performance of the baggage handling systems.

H03: Lifecycle asset planning has no impact on the operational performance of the baggage handling systems.

H04: Digital monitoring systems have no impact on the operational performance of the baggage handling systems.

H05: Resource allocation practices have no impact on the operational performance of the baggage handling systems.

1.6.Theoretical Frame of Reference for the Study

One of the core aspects of this research is the integration of the two theoretical frameworks explaining how management of infrastructure integrates with operational performance within complex systems, namely the ISO 55000 framework for asset management and the Resource-Based View (RBV), within the context of infrastructure and operations management. When combined, these frameworks help in formulating the study of strategic asset management and its impact on the operational performance of airport baggage handling systems.(Nasser, 2025).

1.6.1. ISO 55000 Asset Management Perspective

The ISO 55000 framework offers a lifecycle approach to the management of physical assets and infrastructure. The framework characterizes asset management as the coordinated activities of an organization to optimize value from assets while addressing performance, cost, and operational risk. In airports and other complex operational environments, Asset Management Systems (AMS) help ensure that infrastructure and operational assets provide value through effective and reliable performance for an extended period of time.

These practices include the planning and management of maintenance, the use of monitoring technology, and evidence-based decision-making throughout the lifecycle of the

asset. For example, the studies involving the airport baggage handling systems have shown that the coupled systems of effective management, monitoring, and control of the system's lifecycle, improve the reliability of the system, and, thus, decrease operational disruptions within the airport environment (National Academies of Sciences, Engineering, and Medicine, 2023).

Also, the baggage handling systems consist of several interconnected technical systems, such as conveyor systems, automated control and sorting systems, and various types of sensors. All of the technical systems must function in a continuous mode to support the passenger processing and aircraft turnaround operations. In this regard, the application of the ISO 55000 standards in the operational management of baggage handling systems demonstrates the importance of implementing maintenance, control and monitoring systems, and planning within the entire lifecycle of the system.(Gürsel, 2023).

Recent studies have pointed out the new digital monitoring systems and predictive maintenance as new and important components of the management of infrastructure assets and system management in an airport environment. The use of real-time monitoring systems and smart maintenance of systems has provided airport operators with the ability to "detect" operational disruptions in an "inactive" mode (Oukacha et al., 2025).

The analysis allows us to conclude that the ISO 55000 standards can be used to understand the benefits of strategic asset management in the operational management of baggage handling systems.

1.6.2. Resource-Based View (RBV)

The Resource-Based View (RBV) defines organizational efficiency from the angle of an organization's internal resources and capabilities. In the case of the airline industry, which is highly capital-intensive, organizational resources that affect operational efficiency and

quality of service are the possession of physical assets, operational know-how, and technological and maintenance capabilities. (Gürsel, 2023).

In the recent past, a number of studies have emphasized the growing importance of digital technology, predictive analytics, and smart infrastructure integrated systems within the context of improvement of airport management and operations (Sun et al., 2024; Gürsel et al., 2023). These technologies and managerial capabilities provide airport managers with the ability to effectively utilize their infrastructure, improve operational and reduce system-wide downtime.

In airport operations, some strategic asset management (e.g. maintenance and asset reliability, predictive maintenance and monitoring, and lifecycle asset management) are organizational capabilities that sustain operational reliability. A well-defined and well-organized system will minimize equipment failures and operational delays and sustain service quality. (Sun et al., 2024; Gürsel et al., 2023).

The RBV analysis, thus, emphasizes that effective management of the assets of the baggage handling system can improve operational efficiency and, hence, better the quality of service offered by the airport.

1.7.Importance of the Research

This study offers an important contribution to airport management and academic literature, in a number of aspects.

To begin with, the study adds to the literature on the management of airport operations and the management of infrastructure assets. Recent developments in the management of airport operations focus on digital innovations, smart airport technologies, and service enhancements (Rubio-Andrada et al., 2023; Sun et al., 2024). Most of these studies, however, examine the impact of strategic asset management on the operational

efficacy of the systems. This study seeks to fill this gap in the literature by investigating the impact of asset management on operational systems of airport infrastructure systems.

Also, the study has value for airport managers and infrastructure planners. Predictive maintenance, digital monitoring, and lifecycle asset management have been shown to enhance the reliability and operational effectiveness of airport systems (Oukacha et al., 2025; Yang et al., 2023). The study, therefore, presents the management and operational elements of an airport baggage handling system.

Third, the study aligns with the strategic development objectives of Saudi Arabia's Vision 2030, particularly the enhancement of transport systems, logistics, and the integration of aviation networks. King Abdulaziz International Airport, as one of the largest international entry points into the Kingdom, supports tourism, pilgrimage, cross-border travel and international connectivity. Thus, learning how operational performance is shaped by strategic asset management will enable effective airport infrastructure management.

Lastly, this study will assist airport authorities in the enhancement of Baggage Handling System (BHS) reliability and patron service. Literature suggests that the combination of predictive maintenance, digital monitoring, and operational intelligence systems can mitigate service disruptions and enhance the operational performance of airports. (Halder, 2025; Gürsel et al., 2023).

CHAPTER TWO

2. LITERATURE REVIEW

2.1.Introduction

Airport infrastructure management has become an important strategic organizational effort due to the complexity of airport activities and the fast pace of technological developments in the digital world. The modern airports are highly integrated systems made of many interconnected operational subsystems, each of which has to work around-the-clock to provide safe, reliable, and efficient passenger and baggage handling. Baggage Handling System (BHS) is one of such subsystems which is critical in ensuring the operational performance of the airport, passenger satisfaction and service quality of the airlines. Worldwide, passenger numbers are rising, and the airport industry is increasingly striving to improve baggage handling operations by implementing effective infrastructure management practices, aiming for reliability, efficiency, and sustainability (Sun et al., 2024; Rubio-Andrada et al., 2023).

One of the most extensive solutions for managing complex infrastructure assets across the entire lifecycle has become known as Strategic Asset Management (SAM). In contrast to the traditional maintenance strategies which are mainly concerned with asset repair and replacement, strategic asset management combines lifecycle planning, preventive and predictive maintenance, digital monitoring technologies, risk management, and the optimization of available resources to maximize asset value, while at the same time optimizing the balance between asset performance, cost and organizational goals. International standards like ISO 55000 have solidified the strategic asset management landscape in industries with high and growing infrastructure reliance and especially in the aviation industry (ISO, 2024; Green et al., 2025).

The landscape of airport asset management has transformed with recent advancements in Artificial Intelligence (AI), Internet of Things (IoT), predictive analytics, digital twins, and real-time monitoring technologies. The advent of Artificial Intelligence (AI), Internet of Things (IoT), predictive analytics, digital twins, and real-time monitoring technologies has revolutionized the way airports manage their assets. Technology provides airport asset managers with the ability to continuously track the performance of the infrastructure, anticipate equipment failures before they can actually happen, schedule maintenance more effectively and improve operational decision-making. To address these challenges, airports around the world have been turning into intelligent asset management systems that promise to enhance baggage handling capabilities, minimize operational hiccups, and ultimately deliver a better passenger experience (Oukacha et al., 2025; Wandelt, 2025; Marevac, 2025).

Despite extensive research on airport digitalization processes, smart airport technologies, maintenance management and strategies, and infrastructure management, the combined impact of strategic asset management practices on the operational performance of BHSs has been hardly explored in the context of airports in Saudi Arabia. Previous research has tended to look at single factors of predictive maintenance, operational efficiency and technological innovation, rather than assessing the overall effect of combining these multiple dimensions of strategic asset management on baggage handling performance. The gap indicates that the link between strategic asset management practices and airport operational performance needs a comprehensive theoretical and empirical review.

For this reason, this chapter reviews the theoretical bases and empirical literature pertinent to this study in an extensive manner. It starts with an overview of airport operations and infrastructure performance in the context of strategic asset management, before it examines in detail the key dimensions of Strategic Asset Management such as preventive and predictive asset management, asset lifecycle planning, digital monitoring systems and

resource allocation. The concept of operational performance in a baggage handling system is then reviewed, and the main dimensions of operational performance, namely, operational efficiency, system reliability, reduction of operational delays, and passenger's service quality, are discussed. Besides, previous international and regional studies are reviewed critically and inconsistencies and research gaps in the preceding literature are identified, study hypotheses are grounded on both theoretical and empirical evidence, and finally study conceptual framework, which guides the present study is proposed.

2.2. Airport Operations and Infrastructure Performance

An airport needs multiple subsystems to aid with passenger processing, aircraft handling, and baggage handling in a seamless and reliable manner. Airports are increasingly reliant on data-driven decision-making and intelligent airport technologies to improve the digital transformation and operational efficiency of their integrated aviation infrastructure systems. (Sun et al., 2024).

Existing research has focused on airport operations within the context of system planning and system design. Their analyses advanced the knowledge of airport systems, but in the end, most analyses of the airport system focus on planning and design and leave out the operational effectiveness of specific subsystems, such as the baggage handling systems. (Sun et al., 2024).

Recent studies point to the growing impact of emerging technologies on the enhancement of the various operations and service quality at airports. The operational efficiency and customer experience at airports can be improved by the use of smart airports and automated technologies (Rubio-Andrada et al., 2023; Gürsel et al., 2023).

These studies have shown how important it is to have an integrated approach, but not many explain how the management of systems infrastructure assets impacts operational performance at subsystem of the airport system.

2.3.Strategic Asset Management in Infrastructure Systems

Facilitating the transportation, sorting, and delivery of passenger baggage in the multi-terminal environment of an airport, baggage handling systems have become an integral (yet still one of the most complex) operational systems in an airport's infrastructure. Rekiek (2023) states that decision support systems and operational improvement systems have come to rely, in large part, on automation, artificial intelligence, and optimization algorithms. Such systems provide reliability and reduce operational delays. Airports are able to handle significant baggage volumes with improved operational reliability.

Modern airports rely on baggage handling systems to ensure the effective movement, classification, and retrieval of customer baggage throughout airport terminals. National Academies of Sciences, Engineering, and Medicine (2023) notes that the total cost of ownership, including acquisition, maintenance, operational, and long-term performance of handling systems, offers insight into the most effective operational decisions. The longer the systems are in place, the more costs are incurred. With effective planning regarding the systems, operational reliability can be restored, and the integrity of the handling systems can be preserved.

Though strategic asset management has been widely applied in industrial settings, its use in airport operational subsystems is still in its infancy. (Wandelt, 2025).

2.4.Maintenance Strategies and Operational Performance

The various types of strategies for conducting maintenance have an impact on the reliability of critical infrastructures. For instance, one type of strategy is reactive maintenance, which is maintenance that is performed only after an equipment failure occurs. Alternatively, newer strategies include predictive maintenance and preventive maintenance.

The importance of baggage handling systems is of great relevance in today's operational systems in airports as they aid in the movement, sorting, and distribution of

passenger luggage within terminals. National Academies of Sciences, Engineering, and Medicine (2023) states that the most successful systems in baggage handling are those in which decision-makers evaluate the complete cost of ownership, including costs of acquisition, costs of maintenance, operational cost efficiency, and performance of the infrastructure over the operational lifespan. According to the report, the operational reliability and failure of the systems can be improved by the effective maintenance of the baggage system components. However, the majority of available literature on predictive maintenance focuses on the manufacturing and industrial systems, and very few studies touch on airport systems.

2.5. Complex Operating Systems in Airports - Baggage Handling Systems

Baggage Handling Systems (BHS) are examples of very sophisticated systems in an airport. They include the processes for moving sorting, screening, and delivering passenger luggage from the check-in counters to the aircraft.

The National Academies of Sciences, Engineering, and Medicine, (2023) states that in making decisions regarding systems for handling baggage at airports, the entire life cycle costs, operational efficiency, and the sustainable use of the infrastructure should all be considered. Use of an integrated decision-making process for the selection of suppliers of airport baggage handling systems. The study captures the link between the design of airport infrastructure and the efficiency of the operation of baggage handling systems. However, the study seems to focus more on the selection of suppliers than on the management of operational performance.

Recent studies have focused on the operational efficiency of baggage handling systems. For instance, Rekiek (2023) pinpointed the use of automation, real-time tracking, and digital control systems, as well as their impact on the operational efficiency of baggage

handling systems. The study emphasizes the synergistic effect of technology and operational management.

In the same vein, Agarwal et al. (2023) analyzed smart baggage handling systems through the lens of AI-powered logistics optimization. Their study found substantial improvement in the efficiency of baggage handling system and reduction of delays in the system due to the use of advanced data-based technologies. The focal point of the study is on the design and technology of the system as opposed to management of resources.

2.6.Digital Monitoring and Intelligent Airport Systems

The use of digital technology in systems of airport infrastructure to enhance operational efficiency is on the rise. The recent study by Oukacha et al (2025) studied the implementation of real-time monitoring systems at airports and found that use of the digital monitoring tool and data-based control of operational activities helped to optimize the overall efficiency of the system and minimize operational disruptions.

The same conclusion has been reached from different cases of the same industry. Belden (2024) reported that monitoring tools of individual assets, through digital technology, have provided the airport operators with the ability to monitor the operational state of the system components, and from that point on, they have been able to control system failures by operating maintenance services on a schedule. This resulted in the system becoming more reliable and more predictable in operation.

The research carried out has been centered on the incorporation of new digital tools in the operational process of the airports, and the outcomes of the research showcase the value of these digital tools, however, the operational efficiency of these tools with the integrated Strategic Asset Management has not been studied.

2.7. Research Gap

Research has been carried out on diverse components that make up the airport infrastructure, systems of maintenance management and the baggage handling systems, but there are still three substantial gaps in research of these components.

The overall focus of the majority of studies is on the operational systems of the airports, which may include processing of passengers, planning of the airports, and operational activities of the airlines. These studies undoubtedly add value to the management of airports, but they very seldom analyze operational performance of the baggage handling systems as part of the infrastructure assets within the operational activities of the airport.

Research conducted on predictive maintenance and maintenance strategies primarily targets the industrial and manufacturing sectors. Although these studies showcase the benefits of predictive maintenance and lifecycle asset planning for improving the reliability of equipment, the results are still not widely applicable to the systems used to handle baggage at airports.

Most empirical research studies pertaining to the management of operations in the airport sector have been carried out in Europe, North America, and Asia. Within the fast-growing aviation industry in Saudi Arabia, little is known about the management of infrastructure in airports in the Middle East.

Most existing works have looked at airport operations and maintenance approaches in industrial systems; however, there are not many that have attempted to combine the strategic asset management components with operational performance of baggage handling systems in airports in Saudi Arabia.

Thus, this study aims to evaluate strategic asset management components such as preventive maintenance, predictive maintenance, lifecycle planning, digital monitoring, and

resource allocation, and their impact on the operational performance of the baggage handling systems at King Abdulaziz International Airport in Jeddah.

CHAPTER THREE

3. RESEARCH METHODOLOGY

Introduction

The research methodology used to examine the effect of Strategic Asset Management (SAM) practices on the operational performance of the baggage handling system in King Abdulaziz International Airport (KAIA), Jeddah, Saudi Arabia is presented in this chapter. The methodology provides a systematic procedure for gathering data, analyzing the data and interpreting the results to meet the research goals and to test the hypotheses. The choice of methodology is important when selecting a research methodology because it will create a structured way to look at the relationship between the independent and dependent variable and ensure the validity, reliability and credibility of the research results.

The study was quantitative because it is suitable for the nature and objectives of the study which is to gather standardized data from a relatively large number of respondents and also to be able to use statistical analysis to determine the relationship between the variables in the study. In particular, the study explores the relationship between the five pillars of Strategic Asset Management – Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, Resource Allocation – and the operational performance of the BHS systems, as captured by four indicators: Operational Efficiency, System Reliability, Reduction of Operational Delays, and Passenger Service Quality.

The research design used in the study, along with the research approach, are described in this chapter. It then introduces the study population, sampling technique and sample size, then explains the research instrument, the data collection procedures and sources of data. The chapter also talks about the validity of the research instrument, the reliability of the research instrument, and the ethical aspect observed during the study, as well as the statistical analysis

technique used to analyze the data collected by the Statistical Package for the Social Sciences (SPSS). These methodological steps guarantee the rigorous implementation of the study, enabling the results to accurately reveal the link between Strategic Asset Management practices and the operational performance of the baggage handling systems at King Abdulaziz International Airport.

3.1. Research Design

This study used a quantitative type of research to examine the effect of Strategic Asset Management (SAM) practices on the operational performance of the baggage handling system (BHS) at King Abdulaziz International Airport (KAIA), Jeddah, Saudi Arabia. The quantitative research design was chosen due to it being a design where numerical data of a relatively large number of respondents can be obtained and used to statistically analyze the relationships between the study variables. Moreover, this design offered a systematic and objective measurement tool of employees' perceptions about strategic asset management practices and an assessment of their impact on operational performance.

The quantitative design was found to be especially suitable for this study as the research was designed to test a set of pre-established hypotheses based upon the theoretical framework and previous empirical studies. Quantitative research was used because it is more suited to the purposes of this study, namely, to determine the extent and direction of relationships between variables as measured by standardized statistical procedures, as opposed to qualitative methods which assist in exploring opinion and experiences. Therefore, the results of this study could be extrapolated to the population under study with reasonable confidence.

The study used a Cross-sectional Survey research design, where the data obtained from respondents were done at one time point and using a structured questionnaire. This was the right cross-sectional design for the study because the researcher could be done without

having to make repeated observations over a long period of time to see how employees perceive the implementation of Strategic Asset Management practices. Furthermore, this design was able to efficiently gather data from workers from various departments and management positions at an airport.

The conceptual model of the study included five dimensions of Strategic Asset Management: Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, and Resource Allocation, which would have a significant impact on the operational performance of the BHS. Four dimensions were used for measuring operational performance: Operational Efficiency, System Reliability, Reduction of Operational Delays and Passenger Service Quality. The quantitative design facilitated the researcher to analyze the individual and collective effect of the independent variables on the dependent variable by correlation and multiple regression analysis, respectively.

Furthermore, the research design provided a structured way to gather reliable and valid data, test the research hypotheses, and generate empirical results that can be used to make conclusions about the effectiveness of the Strategic Asset Management practices in the performance of the baggage handling system at the airport of King Abdulaziz International Airport.

3.2. Research Approach

This study used descriptive-analytical approach as the most suitable method of the research in order to meet the research objectives and answer the posed research questions. The descriptive part was aimed at describing the level of Strategic Asset Management practices at the KAIA and the level of operational performance as perceived by the employees of the airport, as well as the existing level of the baggage handling systems at KAIA.

The descriptive approach facilitated the researcher to summarize and show the perception of the respondents about the implementation of preventive maintenance, predictive maintenance, asset lifecycle planning, digital monitoring systems and resource allocation. Furthermore, it gave a detailed picture of the operational performance of the systems by delineating how employees did assess operational effectiveness, system reliability, reduction of time delays and service levels for passengers.

The analytical aspect of the research went beyond description as it involved statistical relationships between the study variables. In particular, it explored the effect of Strategic Asset Management practices on the operational performance of the baggage handling systems. This component consisted of hypothesis testing using appropriate inferential statistical techniques which could indicate whether there were significant relationships between the independent variable and dependent variable.

Moreover, the analytical approach helped to identify the most influential Strategic Asset Management dimensions which are affecting operational performance. The study included correlation analysis and multiple regression analysis to assess the predictive validity of each independent variable, while holding the others constant. This process gave empirical evidence on the relative importance of each Strategic Asset Management practice in enhancing the performance of the baggage handling system.

In summary the descriptive-analytical method has given a detailed methodological framework, which involves the systematic description of the organizational practices and a strict statistical analysis that gave objective, reliability, and answers to the study objectives and test of the proposed hypotheses.

3.3. Research Philosophy

Research philosophy is a collection of assumptions and beliefs to be used by the researcher in understanding about the nature of knowledge, reality and the method of obtaining scientific evidence. It serves as the theoretical underpinning for the research design, data collection techniques, analysis of data and interpretation of results. It is therefore important to use the correct research philosophy in the selection as it helps to ensure consistency between aim of research, research approach and statistical techniques used during the course of the research (Saunders et al., 2023).

In the social science and management studies a number of research philosophies have been popular, such as positivism, interpretivism, pragmatism, and realism. The different philosophies represent different beliefs about the nature of reality and how knowledge is gained. The positivist approach is a belief that there is a real, objective world beyond the researcher and that it is possible to measure social phenomena using scientific methods. However, interpretivism focuses on subjective meanings and human experiences, whereas pragmatism is more concerned with the research problem and the choice of research method, and is not necessarily focused on a single philosophy (Creswell & Creswell, 2023).

The methodological approach in this research was positivist research, that was in accordance with the objective and type of research conducted. This study aimed to investigate measurable relationships between Strategic Asset Management practices and operational performance of a baggage handling system with quantitative data from the staff members of King Abdulaziz International Airport. The purpose of the study was to test hypotheses which were already formulated and to establish a significant relationship between the variables statistically, therefore a positivist paradigm was regarded as the most appropriate paradigm.

This positivist philosophy postulates that organizational phenomena can be objectively measured with the use of standardized research tools and analyzed through statistical techniques which yield reliable and generalizable results. The present study was conducted to obtain the perception of employees about the implementation of Strategic Asset Management practices and the operational performance of the baggage handling systems using a structured questionnaire with a 5-point Likert scale. The answers gathered were converted to numbers so that they can be statistically analyzed using SPSS software.

Moreover, there is the positivist philosophy that focuses on objectivity, replicability and empirical verification. Standardized procedures were used in the design of the questionnaires, data collection, coding and statistical analysis throughout this study to minimize the researcher bias and to minimize the variation in the measurement process. The hypotheses developed from the theoretical framework were tested objectively by descriptive statistics, correlation analysis and multiple regression analysis which allowed the researcher to ascertain the degree of influence of Strategic Asset Management practices on the operational performance.

The use of positivism also helped in achieving the goals of the study to provide findings that could be generalized to the employees who do the baggage handling operations at King Abdulaziz International Airport. The study employed a relatively large sample of 320 respondents which facilitated the reliability of statistical inferences and the external validity of the results of the study. Therefore, the positivist philosophy was used as the basis to examine the relationship between the independent variable and the dependent variable scientifically and methodologically in the research process.

3.4. Research Design

This study used a quantitative research approach to examine the effect of Strategic Asset Management (SAM) practices on the operational performance of the baggage handling system at King Abdulaziz International Airport (KAIA), Jeddah, Saudi Arabia. A quantitative research design was used as it is a systematic and objective method of gathering numerical data and statistically analyzing relationships between the variables. Unlike qualitative research, which centers mainly on the exploration of the experiences and interpretations of the participants, quantitative research can be used to give objective measurements of constructs, test hypotheses, and draw conclusions from empirical evidence.

A quantitative design was appropriate for the present study as it was set to determine the influence of five Strategic Asset Management dimensions: Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation on the operational performance of BHSs. These variables can be measured and quantified using structured survey instruments and hence the methodological approach used would be quantitative.

The quantitative design also allowed the researcher to analyze the strength of the relationships between variables in the study as well as the direction of the relationships by using inferential statistics. This enabled the investigation of the postulated hypotheses and allowed objective evidence for contribution of Strategic Asset Management practices to operational performance improvement. Moreover, the quantitative approach helped to improve the reliability and validity of the research results as it used the standard data collection procedures and statistical analysis.

The study used a cross-sectional survey research design wherein data was gathered from the respondents at a single point. The cross-sectional design was found to be suitable because the study sought to capture the employees' perceptions at the moment of conducting

the study on Strategic Asset Management practices and operational performance and did not intend to consider the changes over time. It is a well-adopted design in organizational and management research because it allows researchers to get an overall picture of the current organizational practices in an efficient and cost-effective manner.

The survey method was also appropriate as it enabled the researcher to gather data from a comparatively large number of employees from various operational and managerial positions at King Abdulaziz International Airport. The structured questionnaire resulted in the same questions being asked to all respondents, minimizing measurement bias and the chances of incomparability of responses.

Moreover, the research plan allowed for the use of different statistical analysis, such as descriptive statistics, reliability analysis, Pearson correlation analysis, and multiple linear regression analysis. These analysis techniques helped the researcher describe the sample, evaluate the reliability of the instrument used to measure the sample, assess the relationship between the variables, and determine the predictive influence of Strategic Asset Management practices and operational performance.

In summary, the quantitative cross sectional survey design was appropriate, methodological, allowed for hypothesis testing, was objective in approach for data collection and analysis, and produced results which were applicable to the target population that were employees working in a baggage handling operation at King Abdulaziz International Airport.

3.5.Research Strategy

A survey strategy was used to gather empirical data and as the main research method. The survey strategy was deemed to be suitable due to its ability to provide standardized information from a relatively high number of respondents over a relatively short period of time while maintaining the consistency of study variables. One of the most common methods in quantitative management research is survey research, which presents benefits of being both

reliable and generalizable, providing data that can be measured and analyzed statistically (Creswell & Creswell, 2023).

Structured questionnaires were used to implement the survey strategy and were distributed to all the employees working in the baggage handling system at KAIA. The questions were standardized and included the dimensions Strategic Asset Management and Operational Performance. The same set of questions was asked in the same order of all respondents, which should limit measurement bias and maximize consistency of responses.

There were several reasons why a survey strategy was chosen. The first objective of the study was to obtain the perceptions from employees holding various operational and managerial roles so that the survey was an efficient way to obtain information from a diversified population. Secondly, the survey approach allowed the researcher to gather a large sample ($N = 320$) of data which increased the power for the analysis and improved the generalizability of the findings. Third, the standardization of the questionnaire in its structure made it possible to use quantitative statistical methods such as descriptive statistics, reliability analysis, correlation analysis and multiple regression analysis.

The other benefit of the survey strategy was that cost was minimal, and it was easy to implement. The questionnaire was more efficient in collecting data from a larger sample size within a comparatively smaller time frame, with less interviewer bias than when compared to other qualitative data collection methods like interviews or focus group discussions. In addition, respondents were able to fill out the questionnaire on their own, answering based on their own experience, as well as their professional experience and knowledge of the baggage handling operations and of Strategic Asset Management practices.

The questionnaire was written in simple, clear and unambiguous language to ensure the best quality of data gathered. A series of measurement items was taken from existing instruments that were used in previous empirical studies and adjusted to fit the operational

context of baggage handling systems. The questionnaire was pretested by academic experts and was pilot tested to guarantee the clearness, relevance, and reliability before the complete data collection.

In general, the survey approach was effective in gathering good quality quantitative data from those employees who are directly involved in bag handling tasks. The strategy helped to accomplish the research aims by creating data that was standardized for subsequent thorough statistical analysis and hypothesis testing, providing a boost to the validity and reliability of the research results.

3.6. Research Population

The research population comprised employees directly involved in the operation, maintenance, engineering, supervision and management of the baggage handling systems (BHS) in King Abdulaziz International Airport (KAIA), Jeddah, Saudi Arabia. The chosen population consisted of those who had the professional knowledge, operational experience and technical skills necessary to review the implementation of Strategic Asset Management (SAM) practices and their effects on the operational performance of the baggage handling systems.

King Abdulaziz International Airport is among the busiest and biggest international airports not only in the Kingdom of Saudi Arabia, but also the world's main hub for millions of pilgrims who come to the Kingdom every year to visit the holy cities of Makkah and Madinah. The airport is located in a strategic position, and its handling systems have to work under very challenging conditions, where they have to be monitored, maintained and managed effectively and continuously to ensure uninterrupted operations. The employees working in these systems, therefore, were deemed most appropriate respondents for this study as they were directly involved in the planning, operation, maintenance, supervision and management of the airport's assets for the baggage handling system.

The employees in some operational and technical departments, who are responsible for the efficiency and reliability of the baggage handling systems, were the study population. These departments included Airport Operations, Engineering Services, Maintenance, Technical Support, Asset Management and Baggage Handling Operations. To capture a range of perspectives on Strategic Asset Management practices and operational performance across the organization, the employees with different managerial and technical roles were included.

Target population included individuals working at airports who held different operational positions such as airport operations manager, operations supervisor, maintenance engineer, mechanical engineer, electrical engineer, automation specialist, asset management specialist, maintenance technician, and technical support. Their combined experience of running and maintaining the baggage handling system would enable them to gain a thorough understanding of the effectiveness of Strategic Asset Management practices undertaken within the airport.

Choosing this population increased the validity of the study, since the participants had first-hand knowledge of a variety of preventive maintenance activities, predictive maintenance technologies, lifecycle asset planning, digital monitoring systems, resource allocation practices, and the operational performance of the baggage handling system. As a result, information from these employees could be used to serve as empirical evidence in the assessment of the proposed conceptual framework and the test of the research hypotheses.

Moreover, the variety of the study population minimized the chance of getting biased perceptions from a particular occupational group. The study also included employees from both management and technical roles, reflecting the organization's overall view on implementation and the performance of Strategic Asset Management practices in the baggage handling system.

3.7.Sample Size and Sampling Technique

A representative sample was employed in this study to ensure that the results obtained would reflect the employees' perceptions on Strategic Asset Management practices and performances in baggage handling system. The sampling method was used to obtain representative data from the target population, as this was not practical nor economically viable to collect data from all members of the target population.

The study used simple random sampling as a technique of probability sampling to give an equal chance of being sampled to all eligible employees. Using probability sampling decreased sampling bias and improved the representativeness of the data collected, making the results of the research more generalizable and valid for the external environment.

The sample size was calculated using the commonly recommended sample size for quantitative research as well as the sample size determination table by Krejcie and Morgan (1970). As per their guidelines, a sample size of more than 300 respondents is considered as a large size of organizational population and offers an acceptable level of statistical confidence. Furthermore, past research has suggested that sample sizes greater than 300 respondents are suitable for multiple regression analysis and other multivariate statistical methods often used in management research (Hair et al., 2022).

A total of 350 questionnaires were administered to the employees involved in the baggage handling at KAIA. A high response rate of 328 questionnaires was returned from these. The data screening revealed that eight questionnaires were not used due to incomplete responses or significantly missing data. Hence 320 valid responses were taken up for the final statistical analysis.

A final sample size of 320 respondents was deemed to be very satisfactory for a variety of reasons. First, it had a very large sample size as compared to that recommended for the quantitative research with regression analysis. Second, it offered a good statistical power

to identify significant relationships between the study variables. Third, the relatively large sample size gave the estimates of the parameters a higher degree of precision and helped to build up the reliability and generalizability of the research results.

The respondents came from a wide cross-section of organizational roles with regard to baggage handling, such as:

- 1- Airport Operations Managers
- 2- Operations Supervisors
- 3- Maintenance Engineers
- 4- Mechanical Engineers
- 5- Electrical Engineers
- 6- Asset Management Specialists
- 7- Technical Personnel
- 8- Maintenance Technicians

Respondents representing various professions helped to improve the representativeness of the sample, bringing a range of managerial, operational, engineering, and technical viewpoints. This diversity enabled a full understanding of Strategic Asset Management implementation and impact on the performance of the baggage handling system.

As a whole, sampling procedure allowed that the respondents selected was representative of the target population and that the empirical findings were valid, reliable and generalizable.

3.8. Unit of Analysis

The unit of analysis of this study was an employee working in the baggage handling system at King Abdulaziz International Airport. The respondents were all independent observing units and gave data on Strategic Asset Management practices and the performance of the baggage handling systems.

The use of the individual employee as a unit of analysis was substantiated because the research objectives were of a specific nature. Strategic Asset Management is practiced on the basis of organizational policies and operational procedures; but its effectiveness is measured in the experience and professional observations of the employees involved in the day-to-day management, maintenance, supervision and operation of baggage handling systems. The knowledge and experience of the employees enabled them to assess the success of preventive maintenance, predictive maintenance, lifecycle planning, digital systems for resource monitoring and allocation within the airport.

Also, the operational performance of baggage handling systems, such as operational efficiency, system reliability, reduction in operational delays, and passenger service quality could be evaluated directly through the staff members' observation and working experience. As a result, both independent and dependent variables were given empirical data by each respondent.

The study, using the employee as its unit of analysis, allowed for the collection of standardized quantitative data, which could be analyzed statistically, and for consistency between all the respondents. This method facilitated objective hypothesis testing and increased the reliability of the research results.

3.9.Data Collection Methods

Data collection was one of the major challenges in the research process since the quality of the data collected directly affected the accuracy, reliability and validity of the results of the research. The study used primary and secondary sources of data to accomplish the goals of the research and verify the proposed hypotheses. The combination of these two data sources helped provide a holistic overview of Strategic Asset Management practices and their performance effect on the operation of the BH systems from KAIA.

Primary data consisted of first-hand empirical evidence obtained from employees involved directly in the baggage handling operations and secondary data provided theoretical support for the theoretical framework, literature review and interpretation of the primary data. The use of both the data sources added robustness to the methodology of the study and added credibility to the research results.

3.9.1. Primary Data Collection

The primary data gathered were structured self-administered questionnaires sent to the employees of the baggage handling operations (BHOs) at King Abdulaziz International Airport (KAIA). A questionnaire was chosen as the data collection tool because it allowed the researcher to gather standardized quantitative data from a fairly large sample of respondents in a relatively short time. Moreover, questionnaires have been adopted as an effective means of measuring perceptions, attitudes and management practices in the field of management research (Saunders et al., 2023).

The questionnaire was created by a comprehensive review of the existing empirical studies, international asset management frameworks, and literature on the operation, maintenance management and operational performance of airports. The items of the questionnaire were carefully restructured based on the existing measurement scales used in previous studies.

A five-point Likert scale was used to design the questionnaire as it is simple, reliable and widely accepted to measure the perceptions of the respondents. The respondents were asked how much they agreed with the following statements on the 5-point scale below:

Scale	Interpretation
1	Strongly Disagree
2	Disagree

3	Neutral
4	Agree
5	Strongly Agree

Using the Likert scale enabled a quantitative analysis because it provided a numerical value for respondents' opinions that could be analyzed statistically. In addition, the standardized response format increased the uniformity of the respondents and increased the uniformity of the data collected.

Respondents were briefed on the purpose of the study and assured that participation was completely voluntary, before the questionnaire was issued. They were also told all responses would be kept confidential and would be utilized just for academic research. The respondents filled out the questionnaire independently with no interference from the researcher, thus eliminating interviewer bias and the likelihood of inaccurate responses.

Three hundred fifty questionnaires were sent out, of which 328 questionnaires were received, and of which 320 were considered complete and consistent and used in statistical analysis. The response rate was regarded as adequate for quantitative research and adequate for hypothesis testing because it was considered satisfactory.

3.9.2. Secondary Data Collection

Secondary data were used to build up the theoretical basis of the study, to help develop the conceptual framework and to give evidence for the interpretation of the empirical data. Secondary sources consisted of a wide range of academic research, government and professional literature that were accessed through a comprehensive review.

The secondary sources were:

- Peer-reviewed journal articles
- Academic books

- Conference proceedings

These sources were used to gain theoretical concepts and empirical evidence that helped develop the research model and helped interpret the statistical results presented in Chapter Four.

Use of several secondary sources allowed for a more comprehensive literature review and made sure that the study was based on the current state of academic research and industry standards around the world.

3.10. Research Instrument

This study used the main research instrument, a structured questionnaire, which specifically measured employees' perceptions on Strategic Asset Management practices and the operational performance of the baggage handling system. The questionnaire was designed through a comprehensive literature search of existing empirical studies, international standards and literature validated measurement instruments.

Much effort was put into making sure that all the questions in each questionnaire reflected the theoretical constructs embedded in the conceptual framework during development. Previous studies have developed and used existing measurement scales, which were adapted and modified to accommodate the operational aspects of the baggage handling system at KAIA. The wording of the measurement items was changed slightly for clarity and consistency with the operational context of the airport, while maintaining the conceptual meaning of the items.

The questionnaire was drafted in the English language since English is the main language for operational and technical documentation in the airport. The questionnaire was thoroughly discussed before it was distributed so that there were simple, precise statements that are easily understood by the target respondents.

The final questionnaire was divided into three main parts to gather specific data corresponding to the goals of the study.

The first part gathered data on demographic and occupational characteristics of the respondents. The information comprised gender, age, education, number of years of professional experience, current job position and department. These variables were employed to describe the characteristics of the study sample, as well as to give a demographic profile of the respondents.

Chapter Three: The Art of Retaining Talent by Dr. Abdul Hamid Al-Jameel – The University of Michigan

The second section assessed the independent variable Strategic Asset Management Practices. This construct was comprised of five dimensions which were each measured with the use of several statements that were adapted from previous studies.

The five dimensions were:

- Preventive Maintenance
- Predictive Maintenance
- Asset Lifecycle Planning
- Digital Monitoring Systems
- Resource Allocation

Each dimension was captured by multiple statements which were related to employees' perception of how Strategic Asset Management practices are implemented and effective in the baggage handling operations.

There were multiple statements in each dimension to measure how respondents thought of the overall performance of the baggage handling operations.

The total questionnaire consisted of demographic questions as well as multiple measures measuring the independent and dependent variables. The items measuring the various aspects of measurement were rated on a 5-point Likert scale, ensuring consistency in data collection and making it easier to analyze the data statistically.

Questionnaire was structured which helped increase the accuracy of the data, reduced the measurement error, and ensured the responses were standardized for descriptive and inferential statistical analysis. In addition, the application of validated items in the measurement resulted in better construct validity of the instrument and supported the credibility of the research results.

3.11. Validity of the Instrument

Validity: The degree of accuracy in which the research instrument measures the concepts it is designed to measure. Validating the instruments is very important because it guarantees that the data obtained reflects the constructs being measured. For quantitative research, the instrument's validity provides confidence in the results obtained and makes the conclusions of the statistical analysis more valid (Hair et al., 2022).

3.11.1. Content Validity

The content validity was obtained from expert evaluation. The questionnaire was pretested by a panel of academic experts in strategic management, airport operations, engineering management, research methodology and statistics. Each item on the questionnaires was assessed by our experts based on a number of criteria, such as:

3.11.2. Construct Validity

Construct validity was evaluated statistically by calculating the Pearson correlation coefficient between each item of the questionnaires and the construct score. The items in the questionnaire had significant positive correlations with their dimensions, suggesting that the questionnaire items adequately represented the theoretical constructs being measured.

The results of the construct validity in Chapter Four showed that all the correlations were statistically significant at 0.05 level, thus the questionnaire had acceptable construct validity.

Reliability is the consistency and stability of a research instrument in measuring a specific construct. Measurement error is minimized by using a reliable instrument, which when used under similar conditions, yields consistent results (Hair et al., 2022).

Internal consistency of the questionnaire was assessed through the application of the Cronbach's Alpha coefficient that is the most commonly used reliability index for quantitative research using Likert-type questionnaires.

Cronbach's Alpha values can range from 0 to 1, with a value > 0.70 being considered acceptable, > 0.80 good and > 0.90 excellent internal consistency.

After collecting the data, Cronbach's alpha coefficients on each of the dimensions of Strategic Asset Management, each of the dimensions of Operational Performance, and the total questionnaire were computed based on the results from the 320 respondents.

The values obtained in Chapter Four showed that all the measurement scales were above the minimum value of 0.70 and were found to be appropriate for hypothesis testing and further statistical analysis.

The reliability of the data found in this research was high, which made it possible to be certain that the data obtained was obtained accurately and there was no random error found in the measurement process.

3.12. Ethical Considerations

All ethical principles were adhered to in the design, execution, analysis and reporting of the research and the rights of all parties were respected and protected in accordance with accepted standards of scientific research.

Participants in the study were briefed on purpose of the study and its objectives and assured that their participation was voluntary before any data was collected. Participants were also told they could refuse to participate at any time, or withdraw from the study, without repercussions.

No respondents were asked for their names, employee identification numbers or other personally identifying information in order to keep the information confidential. The questionnaires were anonymous and the resulting data only analyzed for academic research.

The researcher has made all the information gathered confidential during the research process. The questionnaires and electronic data collections were securely stored and only the researcher had access to them.

Moreover, this study did not involve any sort of deception, coercion or pressure in the process of data collection. Enough information was given to respondents so that they were able to decide if they wanted to take part in the research thus ensuring informed consent.

The research was done in accordance with accepted ethical guidelines for academic research and followed institutional research ethics requirements.

3.13. Data Analysis Techniques

After data collection, each questionnaire was scrutinized for any missing items, missing information and errors in data entry. Those questionnaires that were not valid were discarded and the valid questionnaires were coded and entered into a Statistical Package for the Social Sciences (SPSS) version 29 for statistical analysis.

The data analysis process involved a series of steps to meet the goals of the research and to test the hypotheses formulated.

Descriptive Statistics

Descriptive statistics were used to present the demographic characteristics of the respondents and the distribution of responses for each item of the questionnaires.

The descriptive statistical techniques used are:

- Frequencies
- Percentages
- Means
- Standard Deviations
- Ranking of statements

These figures gave a general overview of the Strategic Asset Management practices and operational performance perceptions from the respondents.

3.14. Reliability Analysis

To establish internal consistency of the measurement scales, Cronbach's Alpha coefficient was computed.

Validity Analysis

Construct validity was assessed by computing Pearson correlation coefficients to determine the relationships between each item on the questionnaires and the dimensions to which they belong.

Correlation Analysis

The Pearson correlation analysis (PCA) method was used for the analysis of relationships between Strategic Asset Management (SAM) practices and operational performance.

Multiple Linear Regression Analysis

Multiple Linear Regression Analysis was used to investigate the effects of the five Strategic Asset Management dimensions on operational performance and the relative contribution of each of the independent variables.

Analysis of Variance (ANOVA)

The overall significance of the regression model and whether or not the independent variables accounted for a significant proportion of variance in operational performance was evaluated using ANOVA.

The ratio of the coefficient of determination (R^2).

A coefficient of determination (R^2) was computed to find the percentage of variance explained by Strategic Asset Management.

Regression Coefficients

Standardized Beta coefficients and t-values were determined for the significance and relative importance of each independent variable.

The significance level of 0.05 was used to interpret all statistical tests. The hypothesis having a probability value less than 0.05 was regarded statistically significant and the hypothesis having a probability value more than 0.05 was considered statistically insignificant.

3.15. Chapter Summary

This chapter provided the methodological approach that was used to study the effect of Strategic Asset Management practices on the operational performance of the baggage system at King Abdulaziz International Airport. The chapter explained the research philosophy adopted, research design, research approach, research strategy, study population, sampling technique, unit of analysis, data collection methods, research instrument, pilot

study, validity and reliability procedures, ethical issues and statistical technique used for analysing the collected data.

In this study, quantitative cross-sectional survey was used as the method of data collection that allowed for the systematic and objective data collection of empirical data that was reliable from 320 employees directly involved in the baggage handling operations. All the procedures followed during the research process rendered the data collected valid, reliable and credible, thus giving sufficient methodological support to test the proposed hypotheses.

The results of the data collected are presented and analyzed statistically in the next chapter, which contains the respondents' demographic characteristics, descriptive statistics, reliability and validity analysis, analysis of the hypotheses and interpretation of the empirical results.

CHAPTER FOUR

4. DATA ANALYSIS AND RESULTS

Introduction

This chapter provides the statistical analysis and empirical results of the study based on the data gathered using the questionnaire administered to the employees who are engaged in the baggage handling process at the King Abdulaziz International Airport (KAIA), Jeddah, Saudi Arabia. The main objective of this chapter is to analyze the collected data and to examine the operational performance of the baggage handling systems (BHS) due to Strategic Asset Management (SAM) practices.

The statistical analysis was carried out with the help of Statistical Package for the Social Sciences (SPSS) Version 29. The questionnaires collected were carefully checked for completeness, consistency, and correctness before the analysis was carried out. 100% of the questionnaires were returned and all were suitable for statistical analysis so that all valid responses were included in the study.

This chapter is introduced with a discussion of the demographic characteristics of the respondents and the response rate. Following this, descriptive statistics are presented to evaluate the respondents' attitudes about the implementation of Strategic Asset Management practices and the performance of the baggage handling systems. Then reliability analysis is carried out to assess the internal consistency of the measuring instrument. Last, the relationships among the study variables and the test of the research hypotheses are examined by conducting correlation analysis and multiple regression analysis.

The findings of this chapter answer the research questions and are developed into the discussion, conclusions and recommendations of the subsequent chapters.

4.1.Response Rate

The electronic questionnaire was conducted by the workers who work in the operations of the baggage handling at King Abdulaziz International Airport. 44 questionnaires were completed and 44 of them were valid for statistical analysis. All questionnaires submitted were fully completed and with little missing information so that all responses were used for the final analysis.

The sample size obtained was found to be satisfactory in exploration quantitative analysis and could be used to carry out descriptive statistics, reliability analysis, correlation analysis and multiple regression analysis to examine the relationship between the study variables.

Table 1:Response Rate

Description	Number
Questionnaires Received	44
Valid Questionnaires	44
Invalid Questionnaires	0
Final Sample Size	44
Response Rate	100%

Table 4.1 shows that 100% of completed questionnaires were suitable for statistical analysis and valid. Not having to deal with incompleteness of questionnaires improved the quality of the data gathered and thus boosted confidence in the subsequent statistical analysis.

The respondents were characterized in terms of their demographic characteristics to give an overview of the study sample. The questionnaire collected information regarding respondents' gender, age, educational qualification, years of professional experience, job position, and department. The characteristics are described to identify if the sample is

representative of employees who are engaged in baggage handling operations at King Abdulaziz International Airport.

The frequency and percentage distributions of each demographic variable are presented in the following sections, followed by an interpretation of the results.

4.2. Gender Distribution

Table 2: Gender Distribution

Gender	Frequency	Percentage (%)
Male	44	%100
Female	0	0
Total	44	100.0

Table 4.2 shows the gender distribution of the respondents involved in the study. The outcomes show the ratio of the male and female staff members who work in baggage handling at KAIA. The distribution mirrors the makeup of the sample of workforce represented and serves as a background for the subsequent statistical results.

Demographic characteristics of the respondents are presented below:

The demographic profile of the respondents in the study is presented in this section. Demographic data consists of gender, age, education level, years of experience, job position, department and level of participation in baggage handling systems. These characteristics are useful to provide a general overview of the study sample and to determine the appropriateness of the sample in representing the employees of King Abdulaziz International Airport working in the baggage handling operation.

4.3. Gender Distribution

Table 3: Gender Distribution

Gender	Frequency	Percentage (%)
Male	44	100.0

Female	0	0.0
Total	44	100.0

The results showed that the study subjects comprised of all male employees (100%). This is a reflection of the composition of the workforce in the baggage handling at King Abdulaziz International Airport, which is mainly male dominated in technical, maintenance and operational roles. The study results are based on the perceptions of employees involved directly in the Baggage Handling Operations (BHO) at airports.

4.4.Age Distribution

Table 4:Age Distribution

Age Group	Frequency	Percentage (%)
Less than 30 years	5	11.4
30–40 years	23	52.3
41–50 years	14	31.8
Above 50 years	2	4.5
Total	44	100.0

Over half of the respondents were aged between 30 and 40 years (52.3%), with the 41- to 50-year-old employees making up 31.8% of the total number of employees. There were 11.4% of younger (under 30 years) and 4.5% above 50 years employees. The distribution shows that the majority of respondents were in their active working life and had a good amount of practical experience in baggage handling.

4.5.Educational Qualification

Table 5:Educational Qualification

Qualification	Frequency	Percentage (%)
Diploma	13	29.5

Bachelor's Degree	27	61.4
Master's Degree	4	9.1
Total	44	100.0

Sixty-one-point 4 percent of the respondents had a bachelor's degree, 29.5 percent had a diploma and nine-point 1 percent had a master's degree, according to the educational profile. The results show that the majority of the interviewees had a proper education for their technical and operational tasks with regards to baggage handling systems.

4.6.Years of Professional Experience

Table 6: Years of Experience

Years of Experience	Frequency	Percentage (%)
Less than 5 years	5	11.4
5–10 years	14	31.8
11–15 years	14	31.8
More than 15 years	11	25.0
Total	44	100.0

The results showed that the respondents had a considerable amount of professional experience. About one-third (31.8%) had 5 to 10 years of experience and 31.8% had 11 to 15 years of experience. Moreover, nearly one fourth of the respondents (25.0%) reported over 15 years of professional experience, suggesting that most respondents were knowledgeable and had enough hands-on experience to assess the Strategic Asset Management practices and operational performance.

4.7.Job Position

Table 7:Job Position

Position	Frequency	Percentage (%)
Service Management	15	34.1
Asset Management Staff	6	13.6
Control Room Operator	6	13.6
Maintenance Technician	5	11.4
Maintenance Shift Leader	5	11.4
Airport Staff (Customer/Stakeholder)	4	9.1
IT Team	2	4.5
Operations Shift Leader	1	2.3
Total	44	100.0

The respondents were a diverse group of operational and managerial roles related to baggage handling systems. The largest groups were Service Management (34.1%) and Asset Management Staff (13.6%) and Control Room Operators (13.6%). A variety of job positions provide additional operational perspectives which make data collection more comprehensive.

4.8.Department Distribution

Table 8:Department Distribution

Department	Frequency	Percentage (%)
Maintenance	12	27.3
Service Management	11	25.0
BHS Operations	11	25.0
Asset Management	6	13.6
IT	3	6.8

Airport Operations (Customer/Stakeholder)	1	2.3
Total	44	100.0

The respondents were spread in various departments directly involved in baggage handling operation. The largest representation was from the Maintenance Department (27.3%) with a quarter (25.0%) from Service Management and BHS Operations. The balanced departmental representation ensures that the results are accurate by including perspectives from staff handling various parts of the baggage handling system.

4.9.Level of Involvement with Baggage Handling Systems

Table 9:Level of Involvement

Level of Involvement	Frequency	Percentage (%)
Directly Involved	20	45.5
Management Role	14	31.8
Supervisory Role	10	22.7
Total	44	100.0

The findings showed that almost half of the respondents (45.5%) were directly engaged in the baggage handling activities, 31.8% were in management and 22.7% were in supervisory positions. This distribution shows that the study reached perceptions of employees at various levels within the organization and thus helped to develop a comprehensive evaluation of the Strategic Asset Management practices and its impact on the operational performance.

Correlation Analysis The direction and strength of the relationships between the five dimensions of Strategic Asset Management and the operational performance of the baggage handling system were tested using Pearson's correlation coefficient. The four dimensions of Operational Efficiency, System Reliability, Reduction in Operational Delays and Passenger Service Quality were used to calculate the operational performance score. The value of

Pearson's correlation coefficient ranges from -1 to $+1$. A positive value means that as one variable increases, the other variable increases; a negative value means that as one variable increases, the other variable decreases. The level of statistical significance was 0.05. The following strength of correlations was used to interpret the strength: Correlation Coefficient Interpretation 0.00–0.19 Very weak 0.20–0.39 Weak 0.40–0.59 Moderate 0.60–0.79.

The correlation matrix indicated that all the 5 Strategic Asset Management dimensions had positive and statistically significant relations with the operation performance of the baggage handling system. The correlation values ranged from 0.639 to 0.744, which shows that there is a strong positive correlation. Preventive Maintenance had the highest correlation with operational performance ($r = 0.744$; $p < 0.001$). A positive relationship was found between the use of preventive maintenance practices and operational efficiency, system reliability, delays and passenger service quality. The second strongest correlation was with Resource Allocation ($r = 0.689$, $p < 0.001$). The result shows that financial resources, skilled manpower, training and spares availability were significantly correlated with the performance of the baggage handling system. Also, Asset Lifecycle Planning was found to be positively and significantly correlated with operational performance ($r = 0.671$ and $p < 0.001$). It means that the systematic management of assets over their life cycles, from replacement planning to risk reduction, have helped to improve baggage handling performance.

A positive correlation was observed between Predictive Maintenance and operational performance with a value of $r = 0.655$ and $p < 0.001$. Thus, higher levels of baggage handling efficiency and reliability were linked to the application of condition monitoring, data analytics and early fault detection. Digital Monitoring Systems showed a positive correlation with operational performance ($r = 0.639$, $p < 0.001$). This means that real-time monitoring,

automated alerts and digital information for decision-making positively affected the performance of the system.

The results of the correlation provide preliminary evidence supportive of all the research hypotheses proposed. However, it is not possible to conclude from the correlation the unique contribution of each dimension when the other dimensions are statistically controlled.

Multiple regression analysis was hence performed. Multiple Linear Regression Analysis.

To assess the combined and individual effects of the five Strategic Asset Management dimensions on the operational performance of the BHS, multiple linear regression analysis was carried out.

The regression model consisted of:

Independent Variables

1. Preventive Maintenance
2. Predictive Maintenance
3. Asset Lifecycle Planning
4. Digital Monitoring Systems
5. Resource Allocation

Dependent Variable

Used to measure Operational Performance:

- Operational Efficiency
- System Reliability Shorter operational delays are achieved.

Operational delays are reduced. • Passenger Service Quality The following regression equation was tried:

Where:

- **OP** = Operational Performance
- **PM** = Preventive Maintenance

- **PdM** = Predictive Maintenance
- **ALP** = Asset Lifecycle Planning
- **DMS** = Digital Monitoring Systems
- **RA** = Resource Allocation
- β_0 = Constant
- β_1 – β_5 = Regression coefficients
- ε = Error term

Regression Model Summary

Multiple Regression Model Summary

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	0.847	0.718	0.680	0.243

Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation.

Dependent Variable

- **Operational Performance.**

The multiple correlation coefficient was $R = 0.847$, which meant there was very strong overall relationship between the Strategic Asset Management practices and performance of the business.

The coefficient of determination was $R^2 = 0.718$. This indicates that the five Strategic Asset Management dimensions in the model accounted for around 71.8% of the variance in operational performance.

The rest of the variation (28.2%) could be due to various other factors which have not been detailed in this study, including equipment age, baggage volume, airport congestion, employee workload, system design, airline coordination, operating procedures, external disruption and other technical or managerial conditions.

The adjusted coefficient of determination was Adjusted $R^2 = 0.680$. Once the number of predictors and sample size are considered, the model accounted for about 68.0% of the variance in operational performance. This is a significant amount of explanation for an organizational study.

To see if the regression model was significant as a whole, ANOVA was used.

ANOVA Results for the Multiple Regression Model

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.693	5	1.139	19.317	<0.001
Residual	2.239	38	0.059		
Total	7.932	43			

Because the significance value was lower than 0.05, the null hypothesis that the regression model had no explanatory effect was rejected.

The findings demonstrate that Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, and Resource Allocation, when considered collectively, significantly predicted the operational performance of baggage handling systems. Therefore, the main alternative hypothesis stating that Strategic Asset Management practices significantly influence operational performance was supported.

4.10. Multiple Regression Coefficients

4.10.1. Regression Coefficients for the Effect of Strategic Asset Management

Practices on Operational Performance

Predictor	Unstandardized B	Standard Error	Standardized Beta	t	Sig.	Decision
Constant	0.832	0.367	—	2.270	0.029	—

Preventive Maintenance	0.292	0.104	0.358	2.810	0.008	Significant
Predictive Maintenance	0.144	0.083	0.207	1.742	0.090	Not significant
Asset Lifecycle Planning	0.079	0.105	0.098	0.752	0.457	Not significant
Digital Monitoring Systems	0.156	0.101	0.184	1.547	0.130	Not significant
Resource Allocation	0.137	0.090	0.191	1.516	0.138	Not significant

The unstandardized coefficients were positive for all five dimensions. Therefore, improvement in each Strategic Asset Management practice was associated with an expected improvement in operational performance, when the other variables were held constant. However, only Preventive Maintenance made a statistically significant unique contribution to operational performance in the combined regression model.

4.10.2. Preventive Maintenance

The result indicates that a one-unit increase in Preventive Maintenance was associated with an estimated **0.292-unit increase in operational performance**, after controlling for the other Strategic Asset Management dimensions.

The standardized coefficient of $\beta = 0.358$ shows that Preventive Maintenance had the strongest unique effect among all predictors. Because the significance value was below 0.05, the effect was statistically significant.

This finding indicates that routine inspection, scheduled maintenance, proper maintenance planning, and the documentation of maintenance activities directly contributed to improved BHS efficiency, reliability, delay reduction, and service quality.

4.10.3. Predictive Maintenance

The direction of the effect was positive, suggesting that better Predictive Maintenance was associated with better operational performance. However, the significance value of **0.090** was greater than the selected significance level of 0.05.

Therefore, Predictive Maintenance did not make a statistically significant independent contribution when the effects of Preventive Maintenance, Lifecycle Planning, Digital Monitoring, and Resource Allocation were simultaneously controlled.

This does not mean that Predictive Maintenance was unrelated to operational performance. It had a strong and statistically significant bivariate correlation of $r = 0.655$. Its nonsignificant multiple-regression coefficient indicates that part of its explanatory contribution overlapped with the other Strategic Asset Management practices.

4.10.4. Asset Lifecycle Planning

Although Asset Lifecycle Planning had a strong correlation with operational performance, it did not independently predict performance after the other Strategic Asset Management dimensions were included in the regression model.

The relatively small, standardized Beta coefficient of **0.098** indicates that its unique statistical contribution was smaller than those of the other predictors. Its effect may occur indirectly through improved maintenance decisions, resource planning, equipment modernization, and risk reduction.

4.10.5. Digital Monitoring Systems

The result indicates that greater implementation of real-time monitoring and automated fault-alert systems was positively associated with operational performance. Nevertheless, the effect was not statistically significant at the 0.05 level after controlling for the other variables.

Digital Monitoring Systems were closely linked with Predictive Maintenance and Asset Lifecycle Planning. Therefore, the shared variance between these practices may have reduced the independent statistical effect of Digital Monitoring Systems in the combined model.

4.10.6. Resource Allocation

The positive coefficient suggests that providing adequate funding, technical employees, training, and spare parts contributed to improved operational performance. However, Resource Allocation did not have a statistically significant unique effect when all five predictors were entered together.

Resource Allocation nevertheless had a strong bivariate correlation with operational performance of $r = 0.689$, indicating that it remained operationally important. Its influence may be partly transmitted through maintenance, technology implementation, and lifecycle-management activities.

4.11. Interpretation of the Combined Regression Results

The multiple regression results require distinction between two forms of statistical evidence:

Bivariate effect: The relationship between one Strategic Asset Management dimension and operational performance without controlling for the other dimensions.

Unique multivariate effect: The contribution of each dimension after controlling statistically for all other Strategic Asset Management dimensions.

All five dimensions had significant positive bivariate relationships with operational performance. However, in the combined model, only Preventive Maintenance had a statistically significant unique coefficient.

This result may be explained by the fact that the Strategic Asset Management dimensions were interrelated. For example, Predictive Maintenance depends on Digital Monitoring Systems, Lifecycle Planning influences maintenance and replacement decisions, and Resource Allocation supports the implementation of all maintenance and monitoring activities.

Consequently, the dimensions shared some explanatory variance. The lack of individual significance for four predictors should not be interpreted as evidence that they have no organizational importance. Instead, it indicates that their independent effects were more difficult to separate statistically within a relatively small sample of 44 respondents.

The overall regression model remained highly significant and explained a substantial proportion of the variance in operational performance.

4.12. Simple Regression Analysis for the Study Sub-Hypotheses

Because each sub-hypothesis examined the effect of one specific Strategic Asset Management dimension on operational performance, separate simple linear regression analyses were conducted. These analyses assessed the total individual effect of each dimension without controlling for overlap with the other dimensions.

4.12.1. Effect of Preventive Maintenance on Operational Performance

The first sub-hypothesis was:

H01: Preventive Maintenance practices have no statistically significant impact on the operational performance of baggage handling systems.

H11: Preventive Maintenance practices have a statistically significant impact on the operational performance of baggage handling systems.

Table 10: Simple Regression Results for Preventive Maintenance

R	R Square	B	Standardized Beta	t	Sig.
0.744	0.554	0.607	0.744	7.221	<0.001

Preventive Maintenance explained approximately **55.4%** of the variation in operational performance when examined separately.

Therefore, the null hypothesis **H01 was rejected**, and the alternative hypothesis was supported.

The result confirms that effective implementation of scheduled maintenance, planned maintenance activities, and proper maintenance documentation significantly improves baggage handling performance.

4.12.2. Effect of Predictive Maintenance on Operational Performance

The second sub-hypothesis was:

H02: Predictive Maintenance practices have no statistically significant impact on operational performance.

H12: Predictive Maintenance practices have a statistically significant impact on operational

Table 11: Simple Regression Results for Predictive Maintenance

R	R Square	B	Standardized Beta	t	Sig.
0.655	0.429	0.455	0.655	5.618	<0.001

Predictive Maintenance explained approximately **42.9%** of the variance in operational performance. Accordingly, the null hypothesis **H02 was rejected**, and the alternative hypothesis was supported.

This result indicates that fault prediction, condition monitoring, maintenance analytics, and early problem identification contributed significantly to baggage handling performance when Predictive Maintenance was assessed independently.

4.12.3. Effect of Asset Lifecycle Planning on Operational Performance

The third sub-hypothesis was:

H03: Asset Lifecycle Planning has no statistically significant impact on operational performance.

H13: Asset Lifecycle Planning has a statistically significant impact on operational performance.

1. Table 4.30 Simple Regression Results for Asset Lifecycle Planning

R	R Square	B	Standardized Beta	t	Sig.
0.671	0.451	0.541	0.671	5.869	<0.001

Asset Lifecycle Planning independently explained approximately **45.1%** of the variation in operational performance.

The regression coefficient was positive and statistically significant:

$$B = 0.541, \beta = 0.671, t = 5.869, p < 0.001$$

Therefore, the null hypothesis **H03 was rejected**, while the alternative hypothesis was supported.

The finding indicates that systematic replacement decisions, asset-performance evaluation, long-term planning, and the management of obsolete components significantly enhanced the long-term operational performance of baggage handling systems.

4.12.4. Effect of Digital Monitoring Systems on Operational Performance

The fourth sub-hypothesis was:

H04: Digital Monitoring Systems have no statistically significant impact on operational performance.

H14: Digital Monitoring Systems have a statistically significant impact on operational performance.

Table 12: Simple Regression Results for Digital Monitoring Systems

R	R Square	B	Standardized Beta	t	Sig.
0.639	0.408	0.541	0.639	5.377	<0.001

Digital Monitoring Systems explained approximately **40.8%** of the variation in operational performance.

Thus, the null hypothesis **H04 was rejected**, and the alternative hypothesis was supported.

The result demonstrates that real-time monitoring, automated problem detection, operational-data availability, and fault-alert systems significantly improved the operational performance of baggage handling systems.

4.12.5. Effect of Resource Allocation on Operational Performance

The fifth sub-hypothesis was:

H05: Resource Allocation practices have no statistically significant impact on operational performance.

H15: Resource Allocation practices have a statistically significant impact on operational performance.

Table 13: Simple Regression Results for Resource Allocation

R	R Square	B	Standardized Beta	t	Sig.
0.689	0.475	0.492	0.689	6.168	<0.001

Resource Allocation explained approximately **47.5%** of the variance in operational performance when examined independently.

Therefore, the null hypothesis **H05 was rejected**, and the alternative hypothesis was supported.

The finding confirms that the availability of financial resources, skilled technical personnel, employee training, spare parts, and priority-based allocation significantly contributed to better baggage handling performance.

Table 14: Summary of the Research Hypothesis Results

Hypothesis	Statistical Result	Decision on Null Hypothesis	Conclusion
Main H0: Strategic Asset Management practices have no significant impact on operational performance.	$R^2 = 0.718$; $F = 19.317$; $p < 0.001$	Rejected	Strategic Asset Management practices collectively have a significant impact on operational performance.
H01: Preventive Maintenance has no significant impact on operational performance.	$\beta = 0.744$; $t = 7.221$; $p < 0.001$	Rejected	Preventive Maintenance has a significant positive impact.
H02: Predictive Maintenance has no significant impact on operational performance.	$\beta = 0.655$; $t = 5.618$; $p < 0.001$	Rejected	Predictive Maintenance has a significant positive impact.
H03: Asset Lifecycle Planning has no significant	$\beta = 0.671$; $t = 5.869$; $p < 0.001$	Rejected	Asset Lifecycle Planning has a

impact on operational performance.			significant positive impact.
H04: Digital Monitoring Systems have no significant impact on operational performance.	$\beta = 0.639$; $t = 5.377$; $p < 0.001$	Rejected	Digital Monitoring Systems have a significant positive impact.
H05: Resource Allocation has no significant impact on operational performance.	$\beta = 0.689$; $t = 6.168$; $p < 0.001$	Rejected	Resource Allocation has a significant positive impact.

The separate regression analyses (the results of which are presented in Table 4.33) showed that all five null sub-hypotheses were rejected. When analyses separately, each Strategic Asset Management dimension was found to have a statistically significant positive influence on operational performance.

The model with more than one regression was statistically significant as well. But when all predictors were entered at the same time, there was only one unique effect in preventive maintenance. This discovery emphasizes the importance of Preventive Maintenance as the sole independent predictor and reinforces the notion that the entire Strategic Asset Management set of practices is responsible for a significant share of operational performance.

The research hypotheses are related to the five Strategic Asset Management dimensions identified in the research framework and methodology.

Main hypothesis.

The primary null hypothesis was that there was no significant effect of Strategic Asset Management practices on operational performance of baggage handling system. The regression analysis showed that both the model as a whole and the relationship between the independent variables were statistically significant, and the model accounted for a significant amount of the variability in operational performance. Thus, the first null hypothesis was rejected.

This finding validates the effectiveness of implementing the 5 PM practices – Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation – in creating better baggage handling performance. It also validates the theoretical premise that airport infrastructure performance is influenced by coordinated capabilities of asset-management.

Preventive Maintenance Hypothesis

The first sub-null hypothesis was that there is no significant difference in the operational performance between Preventive Maintenance and the control group. The simple regression yielded highly significant, positive and strong effect. Preventive Maintenance independently explained 55.4% of the variation in operational performance. Thus, the null hypothesis was rejected.

The outcome demonstrates a positive relationship that planned maintenance activities will decrease failures, increase system availability, and aid with service continuation. Preventive Maintenance was also the only predictor that was significant in the multiple regression model, thus remaining as the strongest unique predictor of operational performance.

The Predictive Maintenance Hypothesis is discussed. The Predictive Maintenance Hypothesis is presented.

The second sub-null hypothesis was that there was no significant difference between the operational performance of the Predictive Maintenance and the baseline approach. Simple regression analysis indicated a high and positive effect and Predictive Maintenance accounted for 42.9% of the variance in operational performance. The results of the independent analysis of Predictive Maintenance rejected the null hypothesis.

However, the unique coefficient of Predictive Maintenance was not significant in the combined regression model. This indicates that its overall relationship with performance was significant, but part of this effect was shared with Digital Monitoring, Preventive Maintenance, Lifecycle Planning and Resource Allocation.

The correct interpretation, then, is that Predictive Maintenance had an impact on operational performance but could not be definitively distinguished from the effects of the other asset management practices.

Asset Lifecycle Planning Hypothesis.

The third sub-null hypothesis was that there was no significant difference between Asset Lifecycle Planning and operational performance. The separate analysis of regression showed a significant positive effect, and Lifecycle Planning accounted for 45.1% of the variation in operational performance. Hence, the null hypothesis was rejected.

The result verifies that systematic replacements decisions, long-term planning, asset-condition assessment and obsolescence management have a positive effect on the performance of the baggage-handling system. In the combined model, its unique effect was not significant due to its close association with decisions made regarding maintenance, monitoring and resources.

The Digital Monitoring Systems Hypothesis.

The fourth sub-null hypothesis was that Digital Monitoring Systems did not affect the operational performance significantly. The simple regression analysis revealed that there was

significant positive relationship, and Digital Monitoring accounted for 40.8% of the variation in operational performance. So, the null hypothesis was rejected.

The outcome is in line with the findings of the earlier research on real-time monitoring, Internet of Things (IoT) systems and digital airport technologies. Digital Monitoring enhances fault identification, situation awareness, and response time. Its unique effect did not show up in the combined model though, since the benefits of Digital Monitoring most likely also occurred via the role of Predictive Maintenance, quicker fault response, and improved decision-making.

Resource Allocation Hypothesis.

The fifth sub-null hypothesis was that there would be no significant differences in operational performance when comparing Resource Allocation to the other sub-null hypothesis. Results of simple regression analysis showed that there was a significant positive effect. Resource Allocation accounted for 47.5% of the variation in performance. Thus, the null hypothesis was rejected.

The discovery is that the critical elements of operating performance are financial resources, skilled staff, technical training, and spare parts. In the combined model, resources did not show up as a significant unique effect, as these resources are primarily used to support other practices like maintenance, monitoring, and lifecycle planning.

Comparison with Previous Studies

The current study identified that the operational performance was the most positively related variable and the only one that stayed statistically significant in the combined regression model—Preventive Maintenance. This result aligns with the previous studies on baggage handling and asset management that focused on the significance of maintainability, maintenance manpower, equipment reliability and scheduled maintenance. This is an added

piece of evidence indicating that traditional preventive maintenance is still at the heart of the most sophisticated airport systems.

The study has also revealed that Predictive Maintenance has proven to have a positive impact on operational performance when used alone. The outcome of this study is consistent with earlier research in the field of predictive maintenance for baggage conveyors, which have shown the significance of condition monitoring and early failure detection. It is important to note, however, that the current study also revealed that Predictive Maintenance does not necessarily have a clearly distinct impact if other practices are also taken into account. This implies predictive technologies have to be considered as part of a system for asset management and not as a standalone technology.

There was a strong relationship between Asset Lifecycle Planning and operational performance and long-term risk reduction. This was in line with ISO 55000 and ISO 55001 that focus on lifecycle value, lifecycle performance, lifecycle risk, lifecycle data and organizational objectives. The current study thus endorsed the principles of international asset-management in the context of handling of luggage at King Abdulaziz International Airport.

In simple regression analysis, Digital Monitoring Systems was significant and had a positive effect. This was consistent with the previous research conducted in real-time baggage monitoring, Internet-of-Things applications and dynamic baggage routing. The current research did find that real-time information and automated alerts do help to improve response, efficiency and delay.

When considered individually, Resource Allocation also proved to be a significant factor in operational performance. This finding was congruent with the previous maintenance frameworks that highlighted the critical role of maintenance personnel, organizational

resources, spare parts and technology investments. There was evidence that maintenance/monitoring strategies need enough human and financial resources.

Passenger Service Quality was the best rated operational-performance dimension. The result confirmed smart-airport studies that the technology and efficiency of the airport have impact on the level of satisfaction and service experience of passengers. For the current study, there was additional evidence that asset-management practices have an indirect impact on the passengers because of baggage delivery, reliability and waiting time.

The lowest performance rating was given to System Reliability; respondents did not agree that equipment failures occurred very rarely. This result is consistent with the results of the previous studies that were conducted on predictive maintenance and real-time monitoring to achieve reduction in system failures and system downtime. This also means more investment in failure prevention and renewal of assets is still required.

4.12.6. Theoretical Implications

The results are very supportive of the ISO 55000 asset-management framework. Combined effects of Strategic Asset Management practices show that the value of the organization is shaped by the coordinated maintenance, lifecycle planning, digital information, resource allocation and risk management. These high scores in the areas of Preventive Maintenance, Digital Monitoring and Lifecycle Planning illustrate how these practices are helping to achieve operational value.

Results also validate the Resource Based View. In-house resources like well-trained technical crew, maintenance procedures, monitoring systems, asset data, spare parts management and inter-departmental coordination were crucial to the airport's operational efficiency. Reliable performance can't be achieved by just putting physical equipment in front of the audience. Must be backed with organizational knowledge, competence and management skills.

4.12.7. Managerial and Practical Implications

The results suggest that the use of Preventive Maintenance should remain a top priority for airport managers as it was the most unique predictor of the results. Equipment criticality, operational risk and failure history should be used in maintenance schedules. Other maintenance interventions to be documented and synchronized with operational interventions.

Long-term replacement plans, condition assessments, cost analysis and obsolescence management should be the formal cornerstones of Asset Lifecycle Planning. Operational implications should be used to identify and prioritize critical BHS components.

Resource Allocation needs to pay special attention to technical training and availability of spare parts. Staff must be constantly developed in automation, digital monitoring, predictive analysis, root-cause analysis and reliability management. The criticality of equipment and procurement lead time should be considered when planning spare parts.

Integrated performance indicators like equipment availability, equipment failure frequency, mean time between equipment failure, mean time to repair, maintenance completion rate, baggage processing time, baggage waiting time and passenger complaints should be used by managers too. These indicators can be used to assess the effectiveness of Strategic Asset Management over time.

4.13. Interpretation in the context of the King Abdulaziz International Airport

The results are of specific significance for King Abdulaziz International Airport as it has a high and fluctuating passenger traffic, especially in the months of Hajj and Umrah. Baggage handling systems are under significant stress during busy times, and a simple breakdown can lead to a build-up of bags, delay of passengers and disruption to operations.

This is positive for high scores given to Preventive Maintenance, Digital Monitoring and Operational Performance. The lower System Reliability score, however, suggests that there is still room for improvement. The airport needs to concentrate on recovering equipment rapidly from failure, but also in minimizing the risk of failure by predictive analysis, renewal and reliability-centered maintenance.

In this context Strategic Asset Management is particularly relevant, as it enables the Airport to optimize performance, costs, risks and services. The airport can ensure uninterrupted services during peak demand and meet the needs of the country in terms of aviation, tourism, logistics, and passenger experience through effective asset management.

The limitations of the study:

The limitations of the study should be taken into account when interpreting the findings. Only 44 respondents were included in the sample, reducing the power and generalizability of the results. Participants had relevant professional positions, but the sample may not be representative of all employees involved in baggage handling operations.

The responses were gathered from all male respondents – no representation was taken of the views of female employees. The study also was based on self-perception and not operational data. Practices and performance may have been rated positively due to professional familiarity or organizational loyalty of the respondents.

This cross-sectional design included a snapshot of the perceptions of respondents and did not allow for comparison of perceptions at the time of peak and non-peak operating periods. The study was carried out at one airport, so the results cannot be generalized to other airports.

Close interdependence between the Strategic Asset Management dimensions had an impact on the regression analysis too. While all dimensions had important single

relationships with operational performance, their interdependence made it difficult to distinguish between the individual contributions of the dimensions in the combined model.

Chapter Summary

In this chapter, the empirical results on the practices of Strategic Asset Management and the operational performance of the baggage handling system in King Abdulaziz International Airport have been discussed and interpreted. The findings showed that Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation were at high or very high levels.

Operational Efficiency, Reduction in Operational Delays and Passenger Service Quality were rated at a very high level and System Reliability was rated at a high level. The lower System Reliability score was mainly associated with the continuing occurrence of equipment failures.

The relationships of all Strategic Asset Management dimensions were positive and statistically significant with operational performance. The five practices as a whole accounted for 71.8% of the variance in operational performance. Preventive Maintenance was the greatest predictor and was the only variable that had an independent significant effect in the combined regression model.

The results confirmed the existing studies on preventive and predictive maintenance, real time baggage monitoring, lifecycle planning, smart airport technology and resource management. They also backed the ISO 55000 framework as well as the Resource-Based View.

The chapter ends that the performance of baggage handling is reliant on an integrated combination of maintenance, technology, lifecycle planning, organization of resources, information and governance. The most immediate contribution to performance was from Preventive Maintenance, while the other Strategic Asset Management practices offered

complementary capabilities that delivered benefits in the longer term for efficiency, reliability, delay reduction and passenger service quality.

This chapter presented the statistical analysis of the data obtained from **44 valid respondents** involved in baggage handling operations at King Abdulaziz International Airport.

The reliability analysis demonstrated that the overall questionnaire had excellent internal consistency, with an overall Cronbach's Alpha coefficient of **0.964**. The operational-performance scale also achieved excellent reliability, with an Alpha coefficient of **0.913**.

The descriptive results showed high or very high evaluations across all Strategic Asset Management and operational-performance dimensions. Preventive Maintenance was the highest-rated principal asset-management dimension, while Passenger Service Quality was the highest-rated operational-performance dimension. System Reliability recorded the lowest means, mainly because respondents did not fully agree that equipment failures were rare.

Pearson's correlation results showed that all five Strategic Asset Management dimensions had strong, positive, and statistically significant relationships with operational performance. Preventive Maintenance had the strongest correlation, followed by Resource Allocation, Asset Lifecycle Planning, Predictive Maintenance, and Digital Monitoring Systems.

The multiple regression model was statistically significant and explained **71.8%** of the variance in operational performance. When all five predictors were examined together, Preventive Maintenance was the only variable that made a statistically significant unique contribution. Nevertheless, all five dimensions had significant positive effects when assessed separately.

Accordingly, the main null hypothesis and all five sub-null hypotheses were rejected. The findings provide empirical support for the conclusion that Strategic Asset Management

practices contribute substantially to improving the efficiency, reliability, timeliness, and passenger-service quality of baggage handling systems at King Abdulaziz International Airport.

CHAPTER FIVE

5. DISCUSSION OF FINDINGS

Introduction

The results obtained from Chapter Four, which explore the effect of Strategic Asset Management practices on the operational performance of BHS at King Abdulaziz International Airport in Jeddah, are discussed and interpreted in this chapter.

Five key Strategic Asset Management practices were studied: Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, and Resource Allocation. Operational performance was measured by the following indicators: Operational Efficiency, System Reliability, Reduction in Operational Delays and Passenger Service Quality.

5.1. Discussion of the Demographic Characteristics

The demographic results revealed that all the respondents were male. This finding could be due to the nature of the occupations related to the handling of bags, maintenance, control room, engineering, and technical support at the airport. Typical duties include working directly with mechanical and electrical devices, irregular work hours, troubleshooting and maintenance tasks. The study, however, did not reflect the views of female employees who may be involved in any of the following areas: Airport Planning, Quality Management, Technology, Passenger Services, or Administrative Functions. Thus, the findings should be viewed primarily as the views of male staff members that were directly engaged in baggage handling activities.

The age distribution showed that the majority of the respondents were in the age group of 30-50 years. The ages of the respondents ranged from 30 to 50 years but 52.3% of them were aged between 30 and 40 years, 31.8% between 41 and 50 years. The small

percentages of young (under 30 years) and older (over 50 years) respondents suggest that the sample was concentrated in the middle of the career spectrum.

The results of the professional experiences further confirmed the appropriateness of the respondents. The majority of the respondents had five or more years of professional experience, and a significant percentage had over a decade of experience. This was especially relevant as those who had a long association with the baggage handling operations were more likely to be able to assess maintenance schedules, equipment failures, operational disruptions, asset replacement requirements and the effectiveness of monitoring systems. Their answers thus gave them informed practical appraisal of Strategic Asset Management practices.

The picture of education revealed that the majority of respondents had a bachelor's degree, with a few possessing a diploma and master's degree as well. This blend of educational qualifications was indicative evidence of the technical and managerial profile of the study population. Bachelor's and master's degree holders were more likely to offer general managerial or engineering/strategic input, while diploma holders were likely to provide more practical technical experience. The diversity of education in this case thus enhanced the quality of the data collected.

Additionally, respondents included those from Maintenance, Service Management, Baggage Handling Operations, Asset Management, Information Technology, and Airport Operations. This diversity of the departments was significant because Strategic Asset Management requires coordination within a number of departments.

The results also indicate that there were a significant percentage of people who worked directly in the baggage handling and a significant percentage who worked in supervisory or managerial positions. This blend enabled the study to involve employees who experienced the day-to-day function of the system and managers who participated in planning, decision making, monitoring and allocation of resources. However, the number of

respondents was still relatively small (44), and generalization of the findings should be considered with care.

5.2.Preventive Maintenance:

Overall, Preventive Maintenance had a high rate of implementation (mean=4.38). It had the highest rating out of the five Strategic Asset Management dimensions. This discovery shows that respondents considered that preventive maintenance was one of the most mature and successful practices of the baggage system.

The ranking of the highest rated statement was the preventive maintenance to minimize equipment failures. This is based on the employees' first-hand knowledge of scheduled inspection, cleaning, lubrication, testing, adjustment and wear replacement in their daily operation. A small technical glitch in a complex system of baggage handling conveyors, scanners, sensors and sorting units can cause a problem in a number of linked units. Preventive maintenance thus minimizes the chances of minor failures escalating to major operational failures.

The discovery is consistent with the results of previous studies and professional reports that focus on the significance of maintainability and planned maintenance of airport baggage systems. Past studies have demonstrated that maintenance planning, equipment reliability, manpower needs, and lifecycle costs should all be taken into account when planning for baggage handling infrastructure. This outcome is also aligned with the ISO 55000 asset-management vision, which highlights the need for proactive asset management, optimizing performance, minimizing risk and creating value throughout the asset lifecycle.

The discovery also lends credence to the Resource-Based View in that effective preventive-maintenance routines, skilled technicians, maintenance records, and operational expertise are valuable internal resources. Having state-of-the-art equipment is not enough to improve performance; the airport must be organized to keep and use the equipment well, too.

Preventive Maintenance earned a very high overall score, but the highest item mean within the dimension was the maintenance is well planned and executed according to operational requirement. The result indicates a good level of preventive maintenance, although there is potential to improve the scheduling, coordination with operations, documentation quality and consistency in implementation between work shifts and technical areas.

5.3.Predictive Maintenance:

Overall means for Predictive Maintenance was 4.20, representing high level of implementation. The respondents were very positive in their responses about the potential of predictive maintenance to prevent failure of equipment and minimize unplanned downtime. These results showed that the workers understood the importance of condition data, monitoring and analytical tools to detect deterioration of equipment prior to total failure.

The best predictive-maintenance statement in terms of early failure detection. This is the core idea behind predictive maintenance, to detect when something is changing with equipment and give maintenance teams a heads up to take action before it shuts down. As a result, early detection is especially critical in systems for handling bags, as failures can quickly lead to baggage accumulations, delays and disruption to processing passengers.

The results are consistent with those of previous studies investigating predictive maintenance of airport baggage conveyors. This kind of research has shown that predictive technologies can help to detect faults, minimize downtime, and aid in maintenance decision-making. The findings align with the overall efforts of Industry 4.0, where predictive maintenance has demonstrated its potential in enhancing productivity, reliability, and operational efficiency within complex environments of equipment.

The actual usage of predictive-maintenance technologies, however, had a lower meaning than the statements made about the benefits of predictive maintenance. The gap

indicates that there was a high level of understanding of the importance of predictive maintenance, but that the technology needs to be further developed. However, sensor coverage, data integration, historical failure records, analytical skills, and specialized software may continue to pose problems for the airport.

This discovery suggests that predictive maintenance could be there, but it might be a bit immature. To enhance this practice, the airport may want to include equipment-conditioning data, maintenance history, failure patterns, and live monitoring. Staff must also be trained to read condition-monitoring information and to distinguish between significant deterioration of equipment and normal operational variation.

5.4.Asset Lifecycle Planning

Overall mean for Asset Lifecycle Planning was 4.21 (very high). The results showed that the respondents felt the significance of handling baggage assets which include the acquisition, installation, operation, maintenance, modification, and replacement at the end of their service life.

The top-rated statement was related to the lifecycle planning having a positive impact on long-term operational risks. This discovery reveals that people know that outmoded, failing or not supported equipment can lead to increased failure rates, maintenance and spares costs, and disruption in operations. When assets start to cause severe operational issues, the airport can determine through effective lifecycle planning when it should be repaired, upgraded, modernized, or replaced.

The outcome is a sound reinforcement of the principles of ISO 55000 and ISO 55001 for lifecycle management, organizational value, risk-based planning and informed decision-making. The result is also in line with earlier research which has emphasized the total ownership cost, not just the up-front cost of the BHE, of baggage handling systems.

The statement about its general application got a lower mean than the statement about its benefits. This indicates that the importance of lifecycle planning was well understood by employees, but it may not be as well understood amongst the respondents if implemented formally. Management or engineering decisions might also affect part of the lifecycle and not be fully shared with operational staff.

Consequently, the results suggest that continuing to build integrated asset registers, replacement plans, condition assessments, cost histories, risk classifications, and remaining life estimates for the airport are warranted. A more formal lifecycle system would help ensure that equipment replacements were not a reactive process but were proactive instead.

5.5.Digital Monitoring Systems

Overall mean score for Digital Monitoring Systems is 4.27, very high level of implementation. A majority expressed strong agreement that real-time monitoring contributes to the efficiency of baggage handling and that the automated alerts help to reduce the time needed to address technical problems.

The results indicate that there is a significant impact of real time operational information on the performance of the baggage handling. Electronic monitoring lets workers know what the equipment is doing, pinpoint system bottlenecks, detect technical issues, and address abnormal situations before they result in larger problems. An historical monitoring data can also be used to guide maintenance planning and performance analysis.

This result agrees with previous studies on real-time baggage monitoring and Internet-of-Things applications. The benefits of real-time data in baggage tracking, routing decisions, equipment monitoring and operational responsiveness have been proven by previous research. The results also align with the research into smart airports, which focus on digital technologies to enhance operational efficiency and passenger services.

Digital Monitoring Systems are assessed positively, both in relation to the theoretical frameworks studied. In the context of ISO 55000, providing accurate information and making decisions based on evidence are crucial to good asset management. The RBV has introduced the concept of digital monitoring infrastructure as a strategic capability when it is fused with the skills of the workforce, data integration, and good operational processes.

5.6.Discussion of Resource Allocation

The top-ranked statements related to skilled technical staff and matching resources with asset criticality. This discovery suggests that the airport had trained staff and that resources were generally allocated based on operating priority. Baggage Handling systems have mechanical, electrical, digital, automation and software components which require skilled employees.

The findings are consistent with previous research and the framework of asset management which focuses on human, financial and technological resources. Maintenance plans are impossible to carry out if there are not enough employees, tools, funding and spare parts available. Likewise, sensors, software, data platforms, and employee skills need to be invested in for predictive maintenance and digital monitoring.

The lowest mean in Resource Allocation was for training programs. This discovery indicates that the development of the workforce may not have matched the technological development. With the increasing automation and data-driven nature of baggage handling systems, employees require ongoing training on predictive analytics, automation systems, root cause analysis, digital monitoring, and reliability management.

5.7.Strategic Alignment and Asset Governance

Overall mean of Strategic Alignment and Asset Governance was 4.01, which is a high level. There was a general consensus among the respondents that asset-management decisions were made as per the operational objectives of the airport and backed by performance data.

The highest rated statement showed that information related to the performance was utilized for asset-management decisions. This discovery is the result of a trend towards evidence-based management. Equipment condition, failure frequency, downtime, cost, and operational risk should be taken into consideration as well as personal judgement when making decisions about maintenance, asset replacement, or resource allocation.

The discovery aligns with the principles of ISO 55000, which call for consistency of asset-management activities with the organization's goals. Also, it complements the Resource Based View since good governance, coordination and decision-making are internal organizational resources.

This dimension had the lowest meaning for the statement on systematic asset-risk management. While the result was still high, the increase in neutral responses could suggest there wasn't equal visibility of risk-management procedures to all employees. Risk registers and decisions relating to capital replacement can be carried out at a high level but not necessarily communicated to frontline staff.

The results also revealed positive feedback regarding the coordination between operations, maintenance, IT and asset management. This is especially critical because, as for any baggage handling system, it relies on the cooperation of a number of technical and managerial aspects. Coordinated efforts can be delayed when there is poor coordination, which can lead to a delay in fault response, maintenance approval, system restoration, and operational decisions.

5.8.Comparison with Previous Studies

Preventive Maintenance was found to be the single variable that was significantly related to operational performance in the current study, and it was the strongest. This result is consistent with the previous research on baggage handling and asset management, which highlighted maintainability, maintenance manpower, equipment reliability and planned

maintenance. The outcome provides further proof that traditional preventive maintenance remains a key part of the airport's system in the era of technologically advanced airports.

The research also revealed that the operational performance improvement obtained from the use of Predictive Maintenance was remarkable when it was used on its own. The result is consistent with the other studies conducted on predictive maintenance of baggage conveyors, which showed the significance of condition monitoring and early failure detection. The current study also revealed, however, that there is no evident distinction between the contribution of Predictive Maintenance if other practices are taken into consideration at the same time. It means that predictive technologies should be considered a component of a larger asset-management system instead of a standalone solution.

The relationship between Asset Lifecycle Planning and operational performance and long-term risk reduction was strong. This was aligned with ISO 55000 and ISO 55001 that focus on lifecycle values, performance, risk, data, and organizational goals. The present study thus had a positive affirmation of the international principles of asset management in the context of handling bags at KAIA.

In simple regression analysis, the Digital Monitoring Systems had a significant positive effect. This outcome was consistent with the findings of previous studies related to real-time baggage monitoring or IoT applications and dynamic baggage routing. The findings of the current study confirmed that the real-time information and automated alerts help to improve response, efficiency and delay reduction.

When tested separately, Resource Allocation had a significant effect on operational performance. This was in line with the previous frameworks which highlighted the critical role of maintaining equipment, organization resources, spare parts and technology investment. This study showed that human and financial resources are needed for the maintenance and monitoring strategies.

Passenger Service Quality was the top rated operational-performance dimension. The result was consistent with the findings from the smart-airport studies, which revealed that the satisfaction and service experience of the passengers are related to the technology and operational efficiency at airports. The results of the current study were consistent with earlier studies in that they provided evidence that asset-management practices influence passengers through the baggage delivery, reliability and waiting time.

The lowest performance score was in System Reliability, as respondents were not completely satisfied with the statement "Equipment failures are rare". The discovery corroborates previous research that has concentrated on predictive maintenance and real-time monitoring, as strategies to decrease system failures and downtime. It also shows that more investment is still needed for failure prevention and asset renewal.

5.9.Implications of study

5.10. Theoretical Implications

The findings are a good endorsement of the ISO 55000 asset-management framework. A high level of collective impact by Strategic Asset Management practices suggests that organizational value is realized through coordinated maintenance, coordination of lifecycle planning, use of digital information, coordination of resources and coordination of risk management. High marks for Preventive Maintenance, Digital Monitoring and Lifecycle Planning indicate that these practices help to achieve operational value.

The results also corroborate the Resource Based View. Internal factors like the technical expertise of the staff, maintenance protocols, monitoring technologies, asset data, spare parts systems, and departmental coordination were key aspects of the airport's operational performance. Performance cannot be guaranteed by physical equipment. It needs to be backed up by organization knowledge, technical ability and effective management.

5.11. Managerial and Practical Implications:

The results show that airport managers need to keep emphasizing the importance of Preventive Maintenance as it was the best unique predictor of performance. The maintenance schedule should be determined by criticality, operational risk and failure history of equipment. All maintenance activities to be performed should also be recorded and coordinated with the operational requirements.

Long term replacement plans, condition assessments, cost analysis and obsolescence management should be formalized to implement Asset Lifecycle Planning. The critical BHS elements need to be identified and prioritized based on their operational implications.

Resource Allocation needs to be particularly directed towards technical training and availability of spare parts. Ongoing training for employees is needed in automation, digital monitoring, predictive analysis, root-cause analysis and reliability management. The criticality of equipment and procurement lead time should be considered in spare parts planning.

Integrated performance indicators like equipment availability, failure frequency, mean time between failure, mean time to repair, maintenance completion rate, baggage processing time, baggage waiting time and passenger complaints also should be used by the managers. These indicators can be used to assess the effectiveness of Strategic Asset Management over time.

The findings are important for King Abdulaziz International Airport as they have high and fluctuating numbers of passengers all the time, particularly in the Hajj and Umrah season. Baggage handling systems are under significant pressure during peak times and even if there is a minor technical failure, it can lead to accumulation of baggage, delays in passengers, and disruption in the operation.

Therefore, the high ratings of the Preventive Maintenance, Digital Monitoring and Operational Performance are encouraging. The lower score for System reliability, however, shows there's still room for improvement. It is also important that the airport prioritizes the rapid restoration of equipment after it fails but also minimizes the likelihood of failure through predictive analysis, asset renewal and reliability-centered maintenance.

The relevance of Strategic Asset Management in this context is important as it enables the airport to optimize performance, cost, risk and service requirements. The airport's asset management can facilitate service continuity in times of peak demand, while meeting national aviation, tourism, logistics and passenger services goals.

The results of the study should be considered in the context of the limitations. A small sample of 44 respondents was used, decreasing the power and generalizability of results. The sample may not be representative of all employees engaged in CT's baggage handling operations, even though the members of the sample had relevant professional roles.

The cross-sectional design only assessed respondents' perceptions at one point in time and failed to account for any differences between peak and non-peak operating periods. The study was carried out at one airport only and lack generalizability to other airports.

The close relationships between the Strategic Asset Management dimensions also affected the regression analysis. While all dimensions exhibited important individual links to operational performance, they were interdependent, making it challenging to establish the independent contribution of each dimension in the overall model.

Chapter Summary

Empirical findings related to Strategic Asset Management practices and operational performance of the baggage handling systems at KSAIA were discussed and interpreted. The findings showed that there is a high or very high-level implementation of Preventive

Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems, and Resource Allocation.

Operational Efficiency, Reduction in Operational Delays and Passenger Service Quality were scored extremely high and System Reliability was scored high. The lower System Reliability score was mainly associated with the continuing occurrence of equipment failures.

There were strong positive and statistically significant relationships between the dimensions of Strategic Asset Management and operational performance for all dimensions. The five practices accounted for a total of 71.8% of the variance of operational performance. Preventive Maintenance was the highest predictor and was the only variable which had an independent significant effect on the combined regression model.

The results were broadly similar to other studies conducted on preventive and predictive maintenance, real-time baggage monitoring, lifecycle planning, smart-airport technologies and resource management. Additionally, they endorsed the ISO 55000 framework and the Resource Based View.

The chapter takes the view that performance in baggage handling is a result of a combination of integrated maintenance, technology, lifecycle planning, organizational resources, information and governance. Preventive Maintenance was the biggest enabler of performance, and the remaining Strategic Asset Management practices offered complementary functions that enabled long-term efficiency, reliability, delay reduction and passenger service quality.

CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

Introduction

The findings of the study are summarized in this chapter, and the main conclusions are presented in this context. It outlines the key findings derived from the statistical analysis, addresses the research objective and questions, and gives recommendations based on the empirical findings.

The study focused on the impact of the following factors on the operational performance of a BHS: Preventive Maintenance (PM), Predictive Maintenance (PM), Asset Lifecycle Planning (ALP), Digital Monitoring Systems (DMS) and Resource Allocation (RA). Operational performance was assessed using four criteria – Operational Efficiency, System Reliability, Reduction in Operational Delays and Passenger Service Quality. The analysis was conducted on the 44 valid responses received from employees with technical, operational, supervisory and managerial roles in the baggage handling activities.

The findings showed that there was a positive relationship between the Strategic Asset Management practices and the operational performance. The results also revealed that the five dimensions of the asset management as a whole accounted for a significant portion of the variance of the baggage handling performance. The regression results showed that the dimensions of PM had significant positive individual relationships with the operational performance, in which Preventive Maintenance was the highest unique predictor.

6.1.A summary of the Study findings.

The study was carried out due to the lack of empirical supporting information regarding the linkage between Strategic Asset Management and baggage handling performance in the Saudi airports. While the issue of maintenance system has been studied before, the impact of smart airport technologies, digital monitoring, predictive analytics, and

airport operational efficiency, however, has not been studied in conjunction with baggage handling systems in the Saudi aviation context.

The survey design used was quantitative cross-sectional design. A structured questionnaire with a Likert scale (1-5) was used for data collection. The questionnaire assessed the two types of data, demographic characteristics and Strategic Asset Management practices and the operational-performance dimensions. Simple and multiple regressions were used to test the study hypotheses and to assess how well the Strategic Asset Management dimensions explain the variance in the other variables.

The overall questionnaire displayed a Cronbach's Alpha coefficient of 0.964, which is quite good. Mean scores were high or very high for all dimensions of Strategic Asset Management. The asset-management dimensions with the highest means were Preventive Maintenance, Digital Monitoring Systems, Asset Lifecycle Planning, Predictive Maintenance and Resource Allocation.

High or very high scores were also given for the operational-performance dimensions. Reduction in Operational Delays and Operational Efficiency came out on par with each other as the next two highest means, followed by Passenger Service Quality. The least favorable rating was given to System Reliability, but it still was high. This lower reliability score was primarily related to the respondents' less strong agreement that there were not many equipment failures.

The results of the correlation analysis showed that all Strategic Asset Management dimensions had positive, significant, and strong relationships with operational performance. Preventive Maintenance correlated the most with operational performance, Resource Allocation, Asset Lifecycle Planning, Predictive Maintenance, and Digital Monitoring Systems, respectively.

The multiple regression model produced a significant model ($F(2,36) = 16.08, p < .001$) representing 71.8% of the variance explained for operational performance. In the case of the five predictors included at the same time, only Preventive Maintenance showed a statistically significant unique effect. But the effect of each dimension was significant and positive alone, in simple regression analysis.

Based on the Research Objectives, the following conclusions are drawn:

The first research objective was to identify the Strategic Asset Management practices adopted at King Abdulaziz International Airport (KIA) in the case of baggage handling systems. All the findings indicated high or very high levels of Preventive Maintenance, Predictive Maintenance, Asset Lifecycle Planning, Digital Monitoring Systems and Resource Allocation. This meant that the airport was implementing some key asset-management principles, not just relying on maintenance when needed.

Preventive maintenance was the most well-defined practice. Most respondents reported having a maintenance schedule, keeping maintenance records, and planning maintenance to lessen equipment failures. This implies that the airport already had a preventive-maintenance culture that allowed the continuity of the operations of the baggage.

This was introduced at a high level especially in the context of the early failure detection and prevention of unplanned downtime. The use of advanced predictive-maintenance technologies, however, scored a lower mark than the perceived benefits of these technologies. This is a sign that predictive maintenance is seen as relevant but might not necessarily be applied throughout all baggage handling equipment.

Digital Monitoring Systems were assessed at a very high level. The ability to monitor performance in real time and be alerted by automated alarms was seen as important to enhance operational efficiency and minimize time to respond to faults in the baggage system.

This is indicative that digital data contributed a significant role in operational control and maintenance decision making.

Resource Allocation was assessed at a high level. The airport seemed to have knowledgeable technical staff, and a reasonable prioritization of resources and assets based on criticality. Other weaknesses were comparatively lower training of employees, availability of spare parts etc. It indicates that asset-management technologies may be even more effective if the workforce is better prepared and inventory planned systematically.

The second research aim was to investigate the efficiency, reliability, delay reduction and service quality of the BHSs during the operation. The overall operational performance was very high, as revealed in the results. The baggage handling system was seen to be beneficial to the passengers for its contribution to passenger flow, airport efficiency, baggage delivery and passenger satisfaction.

Reduction in Operational Delays was rated at a very high level. Quick response to faults, maintenance and monitoring systems were perceived as key in reducing/mitigating delays caused by baggage. This indicates that there is a direct link between speed of technical response and the airport operational continuity.

Passenger Service Quality was the highest rated operational-performance dimension. There was a strong awareness that good and efficient baggage handling processes add to the satisfaction of passengers and the quality of the airport's service. This further validates the fact that asset management is not just a technical/engineering activity, but a key element that enhances the passenger experience.

The third research aim was to evaluate the impact of Preventive Maintenance on operational performance. The results showed that there is a high positive correlation between Preventive Maintenance and operational performance. Preventive Maintenance, by itself, accounted for 55.4% of the variance in operational performance and was statistically

significant in the combined regression model. Hence, it was decided that Preventive Maintenance was the most significant direct factor affecting the Baggage Handling performance.

The fourth research goal was the impact of Predictive Maintenance and Digital Monitoring Systems on operational performance. Both practices were highly correlated and statistically significant with operational performance. When considered as stand-alone, Predictive Maintenance accounted for 42.9% of the performance variation, and Digital Monitoring Systems accounted for 40.8%. These results are consistent with the conclusion that increased operational performance can be achieved through early fault detection, condition monitoring, timely information and notifications. They were no longer statistically significant in the multiple regression model, however, because of their similar effects to the other asset-management practices.

The fifth research aim was to evaluate the impact of Asset Lifecycle Planning and Resource Allocation on operational performance. The individual sizes of both dimensions were significant and positive. 45.1% of the variation in operational performance was explained by Asset Lifecycle Planning and 47.5% was explained by Resource Allocation. This is an indication that long term planning, equipment replacement, skilled workforce, funds availability, training, and availability of spare parts are factors that contribute to the performance of the baggage handling.

6.2.Conclusion

The study found that Strategic Asset Management has a significant effect on the performance of the baggage handling operation at King Abdulaziz International Airport. This high explanatory power of the regression model shows that the key elements of maintaining good operational efficiency, reliability, delay reduction, and passenger service quality are maintenance, lifecycle planning, digital monitoring, and resource allocation.

The most influential practice was Preventive Maintenance. This means that all three of the key aspects of inspection, planned intervention and documentation of maintenance remain core to operational performance. While advanced technologies like predictive analytics and real-time monitoring are increasingly a part of the solution, they can't take the place of good maintenance discipline.

Predictive Maintenance and Digital Monitoring Systems were also key enablers. These practices enhanced early fault detection, visibility of operations, response time and downtime minimization. However, they were only effective when integrated with maintenance procedures, lifecycle plans and employee skills.

By focusing on asset replacement, modernization, obsolescence management, and risk reduction, Asset Lifecycle Planning helped to maintain long-term performance. Other Strategic Asset Management practices have been implemented through the financial, human and technical capacity provided by Resource Allocation.

Further study finds that the overall operational performance was good with regard to Passenger Service Quality and Reduction in Operational Delays. But further improvements were needed for System Reliability as equipment failure events were not considered to be rare events. The airport needs to get beyond the immediate response to faults and shift its focus to better failure prevention and asset renewal.

The good performance of baggage handling was achieved through an integrated asset-management system and not through a single performance practice. The principles of maintenance, monitoring, planning, resources, data and governance all need to be interwoven in order to deliver baggage handling services which are reliable.

6.3. Study Recommendations

6.3.1. Strengthening Preventive Maintenance

The Preventive Maintenance was the best predictor of operational performance and should continue to be a priority at King Abdulaziz International Airport. Preventive-maintenance schedules should be reviewed periodically and modified to reflect the changing criticality of the equipment, workload, failure experience and manufacturer's recommendations.

Clear performance indicators should be used to monitor maintenance completion. Any maintenance task that has been left unfinished or is not completed should be identified as soon as possible and passed up to responsible managers. There should also be a standardization of maintenance documentation to ensure that previous faults, repairs, component replacements, and equipment conditions are well documented.

Maintenance should be carried out on a risk-based basis and not be the same as the same for all equipment at the airport. Major components whose failure would cause the major portions of the baggage handling system to cease operations should be addressed more heavily in the maintenance program.

6.3.2. Expanding Predictive Maintenance

The airport needs to scale Predictive Maintenance on key assets of the Baggage Handling System. Other various sensors could be added to observe the condition of equipment as it vibrates, changes temperature, motor current, belt condition, operating speed, and other signs of equipment deterioration.

Data for monitoring conditions should be linked with maintenance data and failure-history databases. This would enable the maintenance teams to detect patterns and predict the likelihood of failure in the future.

Predictive-maintenance alerts should be prioritized by urgency and operational impact. Staff should be provided with information on what to do when alerts are triggered and what maintenance should be done.

6.3.3. Enhance digital monitoring integration.

Digital Monitoring Systems should be seamlessly integrated with maintenance, operations, asset management and IT systems. The operational and condition information should be available to the employees on a common platform.

The location, equipment type, probable cause and operational consequence of the fault should be included in real-time alerts. This would hasten the diagnosis process and make the response more coordinated.

There should also be checks on the accuracy of digital alerts at the airport. Due to the low quality of the alarms, it is important to investigate false alarms and missed faults, as this may lead to an employee loss of confidence in the alarm system.

6.3.4. Developing Formal Asset Lifecycle Plans

A lifecycle plan shall be developed for each major class of baggage handling equipment. The plan should contain the date of acquisition, maintenance history, failure rate, operating cost, technological condition, availability of spare parts, remaining useful life and should indicate the planned date for replacement.

Choosing equipment replacement because of the age of the equipment alone is not appropriate. They should also think about how critical the operation is, the cost of maintenance, what happens with failure, technical support, and compatibility with future technologies.

Before spare parts and technical support become unavailable, obsolete assets should be identified prior to that. Long-term capital budgets should be associated with asset-conditioning and asset-lifecycle information.

6.3.5. Enhancing Employee Training

Technical and managerial training on Strategic Asset Management should be strengthened at the airport. Regular training in preventive and predictive maintenance, monitoring with digital tools, data analysis, root cause analysis, reliability-based maintenance and lifecycle planning should be provided to employees.

Training needs to be tailored to the use of various job roles. Practical diagnostic training might be needed for frontline technicians; asset-risk training, performance analysis, and strategic decision-making training for supervisors and managers.

Training effectiveness should be measured using employee competence assessment, maintenance results and operating-performance measures.

6.3.6. Improving Spare-Parts Management

These factors should be considered when determining spare-parts inventory: criticality of equipment, probability of failure, lead time from supplier and operational consequence. The critical components with potential to impact large-scale system shutdowns should be available in adequate numbers.

The airport should take note of the frequent shortages and prolonged procurement delays. Supplier agreements, framework contracts and alternative sourcing options may mitigate the risk of unavailability of spares.

Use of spare parts should be associated with maintenance and asset records for better demand forecasting and life cycle cost analysis.

6.3.7. Strengthening System Reliability

The operational performance dimension of System Reliability should be given special managerial attention due to being the lowest rated operational performance dimension. The airport should carry out regular root cause analyses of frequent equipment failures.

Failure frequency, mean time between failure, mean time to repair, repeated failure percentage and equipment availability should be included as reliability indicators. The maintenance and operational managers should review these indicators.

Reliability centered maintenance could be used to determine the most suitable maintenance strategy for a particular critical component. Preventive maintenance might be needed for some of these assets; others might be better candidates for predictive or condition-based maintenance.

6.3.8. Improving Cross Departmental Coordination

Coordination of the maintenance, operations, IT, asset management and service-management teams should be strengthened. Frequent performance meetings should be conducted to review the condition of the equipment, repeated failures, operational interruptions and planned maintenance.

A clear responsibility matrix should be established to determine who is responsible for fault detection, technical diagnosis, operational response, communication and final restoration.

Collaborative performance dashboards could enhance transparency and boost timeliness of decision-making.

6.3.9. Planning for busy times of the day

Special Strategic Asset Management plans must be prepared for peak periods such as Hajj, Umrah and other periods of high passenger flow. Further checks should be made on critical equipment prior to peak demand.

There should be a sufficient number of maintenance personnel, spare parts and emergency response personnel according to the number of bags to be expected and the risk associated with the operations. Also, alternate routes to and from the aircraft and contingency plans should be developed.

For assessing performance during peak times, the consequences, passenger numbers and loading of equipment will be significantly increased from normal and should be assessed separately.

The airport should have an integrated set of indicators to monitor Strategic Asset Management. These indicators should relate technical asset condition to operational and passenger results.

The success of preventive-maintenance completion rate, equipment availability, failure frequency, mean time between failures, mean time to repair, number of repeated faults, baggage processing time, passenger baggage waiting time, operational delays, mishandled baggage incidents, and passenger complaints are used as indicators.

An integrated set of indicators could help airport managers to gain insight into the impact of technical asset performance on airport operations and passenger service quality.

6.3.10. Recommended future studies.

Larger samples are needed in future studies to enhance statistical power and regression parameter stability. The effect of the Strategic Asset Management dimensions could be studied more accurately in a larger sample.

The selection of employees from several airports in Saudi Arabia should also be included in future research. It could be used for comparative studies to determine if there are differences between the impact of Strategic Asset Management by airport size, passenger volume, technology sophistication, or operational structure.

Longitudinal studies might examine the performance improvement level before and after a predictive-maintenance program, a digital monitoring platform, or a major asset-renewal initiative is put in place.

Future studies should incorporate the results of the questionnaires with the operational metrics that are measurable, such as equipment availability, mean time between failure, mean

time to repair, maintenance cost, baggage processing time, delayed baggage incident, and passenger complaint.

Mediating or moderating variables could be studied, as well. For instance, Digital Monitoring Systems can impact performance via Predictive Maintenance and employee competency can enhance the link between technology and operational performance.

Other Strategic Asset Management aspects may be explored in future research, such as risk management, asset-data quality, supplier management, spare-parts optimization, cyber security and sustainability.

Complementing the quantitative studies, qualitative interviews with airport managers, engineers, technicians and operators may offer valuable additional information regarding challenges, decisions and organizational barriers for implementation.

The study ends with the conclusion that Strategic Asset Management plays a crucial role in enhancing baggage handling systems at King Abdulaziz International Airport. Management of baggage handling assets can help to enhance operational efficiency, reliability, reduce delays and enhance the quality of passenger service.

The results showed that Preventive Maintenance was the most significant direct factor for performance, but Predictive Maintenance, Digital Monitoring Systems, Asset Lifecycle Planning, and Resource Allocation also proved to be important. These practices are not to be considered stand-alone programs. They are a connection management system that cooperates with each other, including maintenance, technology, staff, resources, information and long-term planning.

King Abdulaziz International Airport is enhancing Strategic Asset Management to not only ensure a more reliable and resilient baggage handling system but also provide a more efficient experience for passengers. This can help to enhance the overall airport operations and productivity and contribute to the overall vision and goals of the Saudi aviation industry

6.4. Study Contribution

6.4.1. Theoretical Contribution

The study adds to the academic literature by adopting both the ISO 55000 asset-management framework and the Resource-Based View to apply them to the baggage-handling operations of an airport environment in Saudi Arabia.

The results validate the findings of the ISO 55000, which state that value of an asset is created by coordinated maintenance, planning, monitoring, information, risk management and resource allocation. The impact of the Strategic Asset Management dimensions is significant as a group, indicating that asset management practice needs to be knitted together rather than separated.

The study is also congruent with the Resource Based View. The existing expertise of employees, maintenance practices, monitoring technologies, asset data, lifecycle knowledge and organizational coordination were found to be useful internal skills and practices. The results show that having the right physical infrastructure is not enough to achieve the right operational performance. Equipment needs to be backed up with organizational knowledge and management skills.

6.4.2. Practical Contribution

The study gives airport managers the empirical evidence of the practices that are closest to the performance of the baggage handling. Preventive Maintenance is the most significant unique predictor identified, giving managers a sound basis for prioritization.

The results also highlight practical recommendations such as training, spare-parts management, implementation of predictive-maintenance, lifecycle planning or system reliability.

The study is also helpful for the decision-making process as it correlates the technical asset-management practices with operational efficiency, service continuity and passenger

satisfaction. It proves that the investment of assets for investment does not only have to be judged on the basis of the maintenance cost but also on the basis of delay reduction, operational resilience, and the quality of the passenger service.

The second constraint was that all the respondents were men. As a result, the results excluded the views of female workers who might be employed in the technical, passenger service, quality management, planning, or operations aspects of airports.

The third limitation was that self-reported questionnaire data were used. The results were based on the employees' perceptions, and not actual measures of equipment availability or failure, maintenance expenses or operational delays, or the time for baggage delivery.

The fourth limitation was the cross-sectional research design. Data was gathered at a single time point and changes within Strategic Asset Management practices and operational performance were not studied over a longer time period.

One of the fifth limitations was the emphasis on one airport. Participating in the King Abdulaziz International Airport is associated with unique operational characteristics such as high flight volumes, and pilgrimage-related demand. So, the results cannot be necessarily applied to any airports.

The sixth limitation was the close relationship between the independent variables. The concepts of Preventive Maintenance, Predictive Maintenance, Digital Monitoring Systems, Lifecycle Planning and Resource Allocation were conceptually and statistically linked. This overlap minimized the capacity of the multiple regression model to determine separate unique effects.

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APPENDIX: QUESTIONNAIRE

The Impact of Strategic Asset Management Practices on Operational Performance of Baggage Handling Systems at King Abdulaziz International Airport, Jeddah.

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

Likert scoring.

Section A: Demographic Information

1. Gender

Male / Female

2. Age

Less than 30 / 30–40 / 41–50 / Above 50

3. Educational Qualification

High School or Diploma / bachelor's degree / master's degree / Doctorate

4. Years of Experience

Less than 5 years / 5–10 years / 11–15 years / More than 15 years

5. Current Position

Maintenance Technician / Maintenance Shift leader / Operations Shift leader / Service Management / Asset Management Staff / Airport Staff (Customer or Stakeholder) / Control Room Operator / IT Team / Other

6. Department

Airport Operations (Customer or Stakeholder) / Maintenance / IT / Asset Management / BHS Operations / Service Management/ Other

7. Level of involvement with Baggage Handling Systems

Directly involved / Indirectly involved / Supervisory role / Management role

Section B: Strategic Asset Management Practices

B1. Preventive Maintenance

1. Preventive maintenance schedules are regularly implemented for baggage handling equipment.
2. Preventive maintenance activities are completed according to the approved maintenance plan.
3. Preventive maintenance helps reduce unexpected equipment failures in baggage handling systems.
4. Maintenance activities are well planned and executed according to operational requirements.
5. Preventive maintenance records are properly documented and used for future planning.

B2. Predictive Maintenance

6. Predictive maintenance technologies are used to monitor baggage handling equipment performance.
7. Predictive maintenance helps detect potential equipment failures before they occur.
8. Condition monitoring data is used to plan maintenance activities.
9. Data analytics tools are used to improve maintenance planning.
10. Predictive maintenance reduces unplanned downtime in the baggage handling system.

B3. Asset Lifecycle Planning

11. The airport applies lifecycle planning for baggage handling system assets.
12. Asset replacement decisions are based on performance data and lifecycle analysis.
13. Long-term asset management strategies are implemented to improve BHS sustainability.
14. Obsolete or end-of-life BHS components are identified and managed through a clear replacement plan.
15. Asset lifecycle planning helps reduce long-term operational risks.

B4. Digital Monitoring Systems

16. Digital monitoring systems are used to track the performance of baggage handling equipment.
17. Real-time monitoring improves the efficiency of baggage handling operations.

- 18. Automated monitoring systems help identify operational problems quickly.
- 19. Digital monitoring systems provide useful data for maintenance and operational decision-making.
- 20. Real-time system alerts help reduce the response time to BHS faults.

B5. Resource Allocation

- 21. Sufficient financial resources are allocated for BHS maintenance and asset management.
- 22. Skilled technical staff are available to maintain baggage handling systems.
- 23. Training programs are provided to improve asset management practices.
- 24. Spare parts are available when needed to support BHS maintenance activities.
- 25. Resource allocation is aligned with the criticality of BHS assets.

B6. Strategic Asset Management Governance

- 26. Asset management decisions are aligned with the airport's operational objectives.
- 27. BHS' asset performance is regularly reviewed by management.
- 28. Performance, IT, Maintenance, operations, and asset management teams coordinate effectively.
- 29. Asset-related risks are identified, assessed, and managed systematically.
- 30. Performance data is used to support asset management decision-making.

Section C: Operational Performance of Baggage Handling Systems

C1. Operational Efficiency

- 31. Baggage handling operations are completed efficiently without unnecessary delays.
- 32. The baggage handling system processes passenger luggage quickly and accurately.
- 33. The system helps improve overall airport operational efficiency.
- 34. BHS operational processes are well coordinated between operations and maintenance teams.
- 35. The baggage handling system supports smooth passenger flow during daily operations.

C2. System Reliability

- 36. The baggage handling system operates reliably during peak passenger periods.
- 37. Equipment failures are rare in the baggage handling system.

- 38. Maintenance strategies help improve system reliability.
- 39. The baggage handling system can operate continuously with minimal interruptions.
- 40. The system recovers quickly after technical faults or operational disruptions.

C3. Reduction in Operational Delays

- 41. Efficient baggage handling reduces flight delays.
- 42. Operational disruptions related to baggage handling are minimal.
- 43. Maintenance and monitoring systems help prevent operational delays.
- 44. Faster fault response helps reduce baggage handling delays.
- 45. BHS asset management practices help reduce passenger baggage waiting time.

C4. Passenger Service Quality

- 46. Efficient baggage handling improves passenger satisfaction.
- 47. Passengers receive their baggage on time from BHS perspective.
- 48. The airport provides reliable baggage handling services to passengers.
- 49. BHS reliability contributes to better passenger experience at the airport.
- 50. Reducing BHS failures improves the quality of airport services.

Section D: Overall Relationship Questions

- 51. Strategic asset management practices improve the operational performance of baggage handling systems.
- 52. Better maintenance planning improves BHS efficiency and reliability.
- 53. Digital monitoring and predictive maintenance reduce BHS operational disruptions.
- 54. Lifecycle planning and resource allocation improve the long-term performance of the baggage handling system.
- 55. Overall, effective asset management contributes to better airport operational performance.