

**‘Design Balanced Scorecard for Maintenance Department
in King Abd-ulziz Airport Hajj Terminals’**

Abstract

Since Kaplan and Norton introduced the Balanced scorecard (BSC) it had the attention of the whole world. This research aims to measure the effect of maintenance practices and activities on King Abd-ALAziz airport – Hajj Terminal operation process. Recently, the role of maintenance doesn't end at repairing or fixing a machine or system, the maintenance these days playing an important strategic role in achieving business goals. This can be in terms of money (Financial), Process performance (Internal Perspective) Agents satisfaction (Customer Perspective), and Organizational capacity (Learning & Growth Perspective).

The Hajj terminal maintenance department aims to reach the maximum efficiency in terms of clients' satisfactions, staff performance developments, cost reduction, and quality assurance. This research is trying to help the Hajj Terminal maintenance department ensure efficiency of processes and systems by improving KPIs to measure the effect of maintenance activities on its current operation processes.

The value of Balanced Scorecard is the main driver of getting the desired results that helps in exploring the effect of maintenance on terminal's operations. The study creates a Balanced Scorecard to measure the performance of general maintenance practices, and establish KPIs to measure the department performance in all four parts of the Balanced Scorecard from row data.

Key Words: Balanced Scorecard, Maintenance Department, Airport, Hajj Terminals, Quality.

الملخص

منذ أن قدم كابلان ونورتون بطاقة الأداء المتوازن (BSC) ، حظيت باهتمام العالم بأسره. يهدف هذا البحث إلى قياس أثر ممارسات وأنشطة الصيانة على عمليات تشغيل مطار الملك عبد العزيز - محطة الحج. في الآونة الأخيرة ، لا ينتهي دور الصيانة عند إصلاح أو إصلاح آلة أو نظام ، فالصيانة هذه الأيام تلعب دورًا استراتيجيًا مهمًا في تحقيق أهداف العمل. يمكن أن يكون هذا من حيث المال (المالي) ، وأداء العملية (المنظور الداخلي) ، ورضا الوكلاء (منظور العميل) ، والقدرة التنظيمية (منظور التعلم والنمو).

يهدف قسم صيانة محطة الحج إلى الوصول إلى أقصى قدر من الكفاءة من حيث إرضاء العملاء ، وتطوير أداء الموظفين ، وخفض التكاليف ، وضمان الجودة. يحاول هذا البحث مساعدة قسم صيانة محطة الحج على ضمان كفاءة العمليات والأنظمة من خلال تحسين مؤشرات الأداء الرئيسية لقياس تأثير أنشطة الصيانة على عمليات التشغيل الحالية.

قيمة بطاقة الأداء المتوازن هي المحرك الرئيسي للحصول على النتائج المرجوة التي تساعد في استكشاف تأثير الصيانة على عمليات الجهاز. تنشئ الدراسة بطاقة الأداء المتوازن لقياس أداء ممارسات الصيانة العامة ، وإنشاء مؤشرات الأداء الرئيسية لقياس أداء القسم في جميع الأجزاء الأربعة لبطاقة الأداء المتوازن من بيانات الصف. الكلمات المفتاحية: بطاقة الأداء المتوازن ، قسم الصيانة ، المطار ، محطات الحج ، الجودة.

1.1. Introduction

A balanced scorecard is a framework used by organizations to manage and implement strategies. The scorecard links an organization's vision to strategic goals, targets, measures, objectives, and initiatives to enhance an effective and efficient service delivery process. Additionally, it balances the performance measures with financial objectives relating to other sectors of an entity to facilitate the coherence of departmental and organizational goals. Other benefits of a balanced scorecard include prioritizing services, monitoring business progress, aligning daily operations to set strategies, and communication development strategies (Quesado et al., 2018). Therefore, organizations can enhance a smooth flow of services and achieve short-term and long-term goals by implementing a well-defined balanced scorecard.

PPMDC operating Jeddah Airport maintenance department can effectively enhance service delivery using a balanced scorecard that leads to increased customer satisfaction, low operational costs, increased customer satisfaction, and development of department staff. The airport maintenance team performs skilled and unskilled duties necessitating a framework that ensures PPMDC hires the best talent. The right choice of skills will also ensure that there is efficiency in output and unnecessary delays. Some of the duties of PPMDC include response to airport emergencies, maintenance of necessary tools and equipment and accompanying records, the performance of repairs and preventive maintenance of the control tower, hangars, and conducting daily operations that ensures that the airport environment is safe for aircraft and other users. Due to the complexity of the duties, the corporation should adopt a balanced scorecard to implement and revise existing strategies.

1.2. The Problem of the Study

This research will design and examine the applications of a balanced scorecard (BSC) as a tool for measuring and improving maintenance performance in King Abdulaziz Airport Hajj Terminals. Specifically, a balanced scorecard will be designed by the maintenance department and propose the appropriate approach for making performance improvements. A balanced scorecard of the department that the airport aims to improve the four key performance indicators which are financial, customer satisfaction, internal process, and organizational capacity. In this view, it aims to reduce financial costs relating to maintenance, increase customer satisfaction, increase safety and optimize all related internal processes, and improve team capacity and identify the appropriate technology for advancing organizational capacity. Balanced scorecard measurements are important for any organization. However, it has been established that aligning the performance indicators with the organizational or departmental goals is very important in integrating the use of a balanced scorecard. This perspective will be the primary guideline for developing a balanced scorecard for the maintenance department of King Abdulaziz Airport Hajj Terminals. Overall, this research will design that for the maintenance department of King Abdulaziz Airport Hajj Terminals to meet its performance targets, its balanced scorecard should be aligned with the goals of the department.

1.3. Objectives of the Study

The research objectives are:

- 1) To identify maintenance performance indicators of the balanced scorecard that require improvement in the related airport department.
- 2) To illustrate the proper perspective of integrating balanced scorecard as a tool for measuring and improving performance for the airport maintenance department.
- 3) To identify limitations of using balanced scorecards in measuring maintenance performance in the concerned airport department.
- 4) To gather raw data and make them understandable.

1.4. Importance of the Study

Designing the balanced scorecard will help the maintenance department of King Abdulaziz Airport Hajj Terminals to create better strategic plans. Also, designing (BSC) will improve strategy communication and execution inside the department which will lead to improvement in the service applied to PAX and stakeholders. When gathering raw data and converting to do indicators, the management of the department will have better alignment of process. This study will make it easier to illustrate to the head office the improvement of the maintenance department. It will make the efforts shine. Performance reporting will be way faster. By the end of this research the maintenance department of King Abdulaziz Airport will have better alignment in the process.

1.5. Limitaion of the Study

The maintenance department of King Abdulaziz Airport Hajj Terminals aims to improve key performance areas. To achieve this objective, it is necessary to understand the activities and processes that affect maintenance efficiency. A balanced scorecard of the department reveals that it falls short in meeting its performance targets. There is a need to align the desired objectives of the balanced scorecard with the department goals.

2. Theoretical Framework

2.1. Maintenance Management

In today's world, managing maintenance of systems efficiently is not only the matter of saving Money; it is the concept that having well-structured maintenance management is a source of generating profit. Maintenance is no longer a source of loss (if it is well managed), it is in contrast the complement of success for any organizational strategy. Maintenance management is defined as "All the activities of the management that determine the maintenance objectives or priorities (defined as targets assigned and accepted by the management and maintenance department), strategies (defined as a management method in order to achieve maintenance objectives), and responsibilities and implement them by means such as maintenance planning, maintenance control and supervision, and several improving methods including economical aspects in the organization."

The maintenance as a management approach should have (as any management activity) a definite strategy to help achieving its own goals resulting in organization's goals as well.

This is going to "conditions the success of maintenance in an organization, and determines the effectiveness of the subsequent implementation of the maintenance plans, schedules, controls and improvements".

From this perspective, setting a maintenance strategy that ensures efficiency of each task being performed is the key success of any maintenance department. The efficiency in maintenance means "providing the same or better maintenance for the same cost".

In order to develop or implement a specific maintenance strategy, it is important to set the objectives of maintenance then start formulating the strategy. Following is an appraisal of setting maintenance department strategy.

2.1.1. Maintenance Objectives

The objective of the maintenance department must be driven from the organization's objective and support it. However, any maintenance department objectives typically are based on the following:

- **Management objectives:** to ensure that all the resources need to perform maintenance task are well allocated and coordinated to work together with its priorities
- **Technical objectives:** to guarantee having equipment/system available when it is needed and ensuring its reliability over lifetime
- **Regulatory Objectives:** to make sure that all maintenance work are following the regulatory standards in each sector such as electrical, mechanical, or safety regulations
- **Financial objectives:** to perform all the maintenance works at an excellent level with the minimum costs.

These four key points are the core objective of any maintenance department. It needs to be adjusted to support the organization's ones and bear with it to achieve the general goal.

After setting these objectives, it's the time to develop the strategies needed to achieve these objectives.

2.1.2. Maintenance Strategy Formulation

The maintenance strategy can be simply defined as knowing what you want from a maintenance program and knowing how to reach it. To have a successful strategy, it is important to have tactical plans that translate maintenance objectives into clear strategy.

This must take in consideration full understanding of the goals and its related variables. A typical maintenance strategy contains the following:

1. A description of the maintenance department rule and type of services that it offers. In addition, list of direct and in-direct key factors that affect maintenance
2. An appraisal of the regulatory, economic, and financial environment
3. A depiction of future business vision in i.e. five years' time
4. A statement of the mission, guiding principles, and major objectives to be accomplished and the business plan to achieve them.

Once a maintenance strategy is being defined, it must be communicated and implemented in the business. The maintenance strategy as any strategy should be flexible and can be adopted to match any future changes.

2.2. Maintenance Types & Categories

2.2.1. Maintenance Terminologies

As any field, maintenance has its own jargons that are used to describe and define a state or a process. Following is definitions for some of maintenance terminologies that are been widely used in this field (Campbell et al., 2015):

- **Scheduled Maintenance:** is the maintenance work that is executed according to predefined schedule
- **Break-in Work:** work that is been added to a schedule for execution after it has been finalized
- **Corrective Maintenance:** usually known as repairs which means work done to correct or restore a defect back to normal condition

- **Detective Maintenance:** form of predictive maintenance, it is the work done to detect failures that have already occurred but remain undetected because the functionality that has been lost is normally not used or is dormant. This often related to back up or stand by systems
- **Planned Maintenance:** work that is planned in detail in-advance of being scheduled and assigned to work crews for execution. Planning is used to increase effectiveness, and ensuring that the right job is done
- **Predictive Maintenance:** known as Condition based monitoring, is looking for signs of impending failure so a corrective action can be taken before equipment completely breaks down
- **Preventive Maintenance:** is the work done to replace a component or restore a system to its original condition regardless of its apparent condition at that time
- **Emergency Maintenance:** is the work that treated as if it were a truly emergency. Emergency maintenance gets the top priority regardless of any work is being executed

And some more definition (Dhillon, 2002):

- **Reliability:** The probability that an item will perform its stated function satisfactorily for the desired period when used per the specified conditions.
- **Maintainability:** The probability that a failed item will be restored to adequately working conditions.
- **Active repair time:** The component of downtime when repair persons are active to affect a repair.
- **Mean time to repair (MTTR):** A figure of merit depending on item maintainability equal to the mean item repair time. In the case of exponentially distributed times to repair, MTTR is the reciprocal of the repair rate.
- **Quality:** The degree to which an item, function, or process satisfies requirements of customer and user.

There are more terminologies that have been defined locally within any maintenance organization. The above listed jargon is the most widely used in this field.

2.2.2. Maintenance Types Classification

In the way of understanding maintenance types, it's important to understand what it means by Maintenance. Maintenance is "combination of actions intended to retain an item in, or restore it to, a state in which it can perform the function that is required for the item to provide a given service". Many experts are defining maintenance types in today's world, but the most eligible concept classifies maintenance activities into two groups: "actions oriented towards retaining certain operating conditions of an item and actions dedicated to restoring the item to said conditions". Indeed, Preventive and Corrective maintenance are the translation of these groups in the maintenance world

Following is a diagram of maintenance categories and its sub-groups:

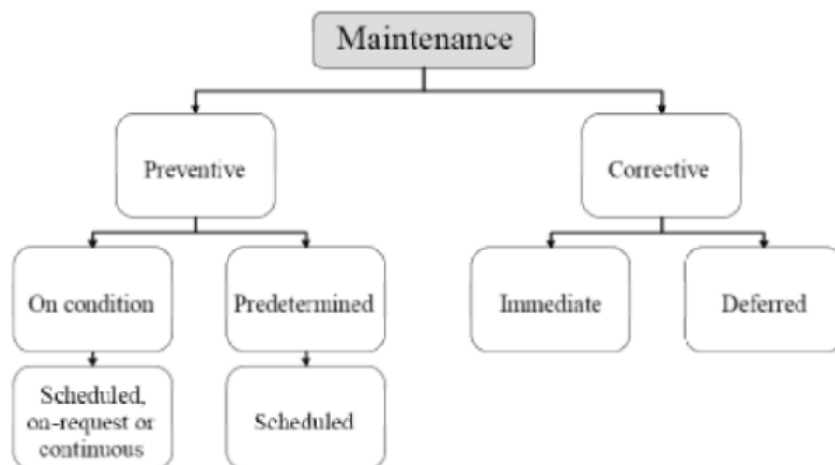


Figure 2.1: Maintenance Categories

Source: The Maintenance Management Framework, By Márquez

2.2.2.1. Preventive Maintenance

Preventive maintenance is defined as a planned work carried out based on predefined criteria in order to minimize or reduce equipment downtime. Under this category, a number of other maintenance activities are:

- Scheduled Maintenance
- Condition Based Maintenance
- Planned Maintenance
- Predictive Maintenance

Each of these sub-categories has its own techniques and procedures to perform a maintenance activity. The preventive maintenance in general can save huge money to the business as maintenance costs are always big issues to the management.

2.2.2.2. Corrective Maintenance

Corrective maintenance is the process of rectifying a fault led equipment or system to stop doing its function. Corrective maintenance can be classified into 5 sub-tasks:

1. Fail-repair: it is the work done to restore a faulty item back to a working condition
2. Salvage: it is the act of using assembled parts of non repairable or damaged equipment to repair other equipments
3. Rebuild: to restore an item to original state in performance, life expectancy, and appearance
4. Overhaul: Restoring an item to its total serviceable state as per maintenance serviceability standards, using the “inspect and repair only as appropriate” approach
5. Servicing: it is the additional work done after a corrective takes place

All of these five tasks can be done either immediately or to be deferred as situation requires. Normally the cost of corrective maintenance is high in terms of money and consequences.

2.3. Key Performance Indicators

“Managing without KPIs gives one the feeling of being lost with no hope” (Smith et al., 2008). The Key Performance Indicators (KPI) is a measure for a business to show how successful it is. KPIs are used within maintenance to know the status of systems and equipment for a short and long period of time. It highlights the strengths and weaknesses to help rectifying a problem or appreciating excellence. In setting the performance measures, it is important to know exactly what will be measured and how often it will be measured.

As previously mentioned, the goal of this research is to measure the impact of maintenance activities on the airport operations. For this reason, this literature review is going to focus on various maintenance and airport operation performance measures then link these measures together to study the effect of maintenance performance on airport operations performance. The following text will discuss the types of KPIs with various examples, and airport operation and maintenance performance measures with more focus on maintenance KPIs and its benefits to both operation and maintenance department.

2.3.1.Types of KPIs

There are two types of KPIs, Leading and Lagging. “Leading KPIs lead to results, such as schedule compliance; lagging KPIs are the results, such as maintenance cost (affected if scheduling is not working)”. The leading KPIs are used to find out how well a part of the maintenance has been done while lagging KPIs show how well it was handled. Moreover, leading KPIs are only indicating the performance of a single action while lagging KPIs can be a result of different leading KPIs. For example, a maintenance cost is lagging KPI; it could be resulted from several leading KPIs such as schedule compliance, or failure rate (figure 2.2).

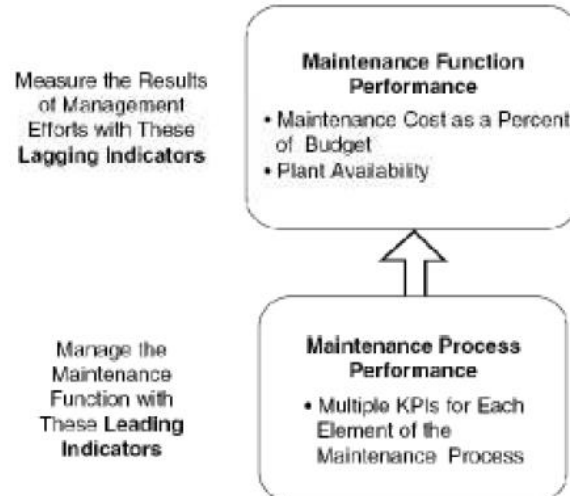


Figure 2.2: Leading & Lagging KPI

Source: Rules of Thumb for Maintenance and Reliability Engineers, by Smith & Mobley

Many maintenance KPIs can be generated according to the needs, an example of general maintenance leading and lagging KPIs with its world class standards are found in table 2.1

Table 2.1: General Maintenance Leading & Lagging KPIs
Source: Rules of Thumb for Maintenance and Reliability Engineers, by Smith & Mobley

KPI Type	Measure	Key Performance Indicator	World Class Target Level
Result/lagging	Cost	Maintenance cost	Context specific
Result/lagging	Cost	Maintenance cost/replacement asset value of plant and equipment	2-3%
Result/lagging	Cost	Maintenance cost/manufacturing cost	<10-15%
Result/lagging	Cost	Maintenance cost/unit output	Context specific
Result/lagging	Cost	Maintenance cost/total sales	6-8%
Result/lagging	Failures	Mean time between failure	Context specific
Result/lagging	Failures	Failure frequency	Context specific
Result/lagging	Downtime	Unscheduled maintenance related downtime (hours)	Context specific
Result/lagging	Downtime	Scheduled maintenance related downtime (hours)	Context specific
Result/lagging	Downtime	Maintenance related shutdown overrun (hours)	Context specific
Process/leading	Maintenance strategy	Percentage of work requests in "request" status for less than 5 days, over the specified time period	80% of all work requests should be processed in 5 days or less
Process/leading Planning element/lagging	Planning	Percentage of work orders with work-hour estimates within 10% of actual, over the specified time period.	Accuracy of greater than 90%
Process/leading	Planning	Percentage of work orders, over the specified time period, with all planning fields completed	95% +
Process/leading	Planning	Percentage of work orders assigned "rework" status (due to a need for additional planning) over the last month.	Should not exceed 2-3%
Process/leading	Planning	Percentage of work orders in "new" or "planning" status less than 5 days, over the last month	80% of all work orders should be possible to process in 5 days or less; some work orders require more time to plan but attention must be paid to late finish c
Process/leading Scheduling element/lagging	Scheduling	Percentage of work orders, over the specified time period, having a scheduled date earlier or equal to the late finish or required by date	95%+ should be expected to ensure the majority of work orders are complete before their late finish date
Process/leading	Scheduling	Percentage of scheduled available work hours to total available over the specified time period	Target 80% of work hours applied to scheduled work
Process/leading	Scheduling	Percentage of work orders assigned "delay" status due to unavailability of personnel, equipment, space, or services over the specified time period	Number should not exceed 3-5%
Process/leading	Execution	Percentage of work orders completed during the schedule period before the late finish or required-by date	Schedule compliance of 90%+ should be achieved
Process/leading Execution element/lagging	Execution	Percentage of maintenance work orders requiring rework	Rework should be less than 3%
Process/leading	Follow up	Percentage of work orders closed within 3 days, over the specified time period	Should achieve 95%+; expectation is that work orders are reviewed and closed promptly

2.3.2. Process for Developing Maintenance KPIs

To start developing an efficient and effective key performance indicators for a maintenance activities, here are some steps that worth looking before establishing the process:

1. Start with higher management. Set up a learning session for showing the value of KPIs, how leading & lagging KPIs differ, and how it could affect a Department' future. Conduct similar session for lower level involved employees

2. Compare the existing situation of maintenance activities and results against available best practices in similar field
3. Start making a plan for establishing KPIs that includes:
 - Identification of all the maintenance activities
 - Work flow during each single activity
 - Prosperities of each leading and lagging KPI
 - Final targets and world class standards for each KPI
4. Implement the process and start acting through leading KPIs. Involve other people to review the result.

2.3.3. Maintenance Manager KPIs Dashboard

The maintenance manager dashboard is a special group of KPIs that helps maintenance managers manage and control all the maintenance process and activities. Following is an example dashboard that maintenance manager may use:

- Overall Equipment Effectiveness (OEE)
 - Availability
 - Performance Rate
 - Quality Rate
- Mean Time between Failure (MTBF)
- Maintenance Cost per labor
- Material cost
- Safety incidence number
- Percentage of outside contractor maintenance work/cost
- Number of in-operation equipments & systems
- Time taken to respond for maintenance breakdowns
- Time taken to clear a breakdown
- Number of breakdown per day
- Number of breakdown per equipments & systems
- PM schedule compliance

By defining these indicators, it provides a clear picture about how well maintenance is doing. This helps in performing any improvements or to value work done. Remember to use the leading KPIs because it's manageable and look for the results in the lagging KPIs.

2.4. Airport Maintenance Performance Measures

As in any business, maintenance plays a fatal role in success and reaching goals. In addition, maintenance undertakes high responsibility for customer's safety and convenience especially at public services places such as airports and hospitals. For these reasons, airport maintenance must maintain a high level of performance to guarantee passengers and airport users with outstanding degree of safety and convenience. In order to do so, airport maintenance must have its own performance measures that show how well things are going on and help rectify any troubles if occurred. In this research, a number of maintenance performance measures will be presented in order to assess the performance of the maintenance and its impact on airport operations.

2.4.1. Percentage of completed PM during period of time

This shows the percentage of completed PMs over the scheduled period of time. The benefit of using this indicator is to track the progress of the PM process in a frequent manner to spot any delays that may occur. The formula used is:

$$\text{Completed PM} / \text{Total PMs} \times 100$$

2.4.2. Percentage of non-completed PM during period of time

This calculates the percentage of non-completed PM work over the total PMs issued in a given period of time. The benefit of using this indicator is to show the progress of preventive maintenance at any point of time and compare it to the schedule. The formula used is:

$$\text{PMs non-completed} / \text{Total PMs} \times 100$$

2.4.3. Percentage of non-completed PMs due to unavailability of spare parts

This shows the percentage of PMs being hold for the lake of spare parts needed to complete the work. This indicator shows the effectiveness of material planning and helps in making decisions for future work. The formula is:

$$\text{Non-completed PM due to unavailability of spare parts} / \text{Total PMs} \times 100$$

2.4.4. Percentage of non-completed PMs due to unavailability of equipment

This indicator shows the percentage of pending PMs due to unavailability of equipment for the reason of equipment being in operation or no access to it. The benefit for using this indicator is to show the communication effectiveness between various departments in order to achieve the common goals.

$$\text{Non-completed PM due to unavailability of equipment} / \text{Total PMs} \times 100$$

2.4.5. Number of service calls per flight

Calculates the number of service calls received during specific flights. This will be recorded randomly over various days to check if there any trend of failures occurring with different types of flights.

2.4.6. Total service calls per day

This indicator show the total number service calls and request per day. This only indicates the services being requested from other departments or customers those not initiated from maintenance department.

2.4.7. Mean time between failures for critical equipment/ system

This indicator will focus only on the equipments/ system those are vital in airport functioning and any failure of it can cause negative impact on operations.

2.4.8. Failure frequency for critical equipment/system

This indicator will also focus only on the equipments/ system those are vital in airport functioning and any failure of it can cause negative impact on operations.

2.5. Percentage of satisfactory maintenance jobs

Represent the number of maintenance jobs that been carried out at satisfactory level. This indicator will give an indication of the quality of maintenance over certain periods of time.

2.5.1.Total PM down time

Indicate the total preventive maintenance down time for all the equipments/systems in the airport. The less down time the better utilization for assets.

2.5.2.Total CM down time

Represent the total down time for all equipments/systems during any corrective maintenance activity.

2.5.3.Percentage of PM work require rework

Calculate the percentage of preventive maintenance that wasn't successful and need another rework from total PMs. This indicates the quality of work being done by the maintenance team.

2.5.4. Percentage of CM work require rework

Represent the percentage of corrective maintenance jobs carried out and needed additional rework after. This indicates the quality of work being done by the maintenance team.

2.5.5. Percentage of work order open after specific period of time

This indicator is used to know the progress of work orders every specific period of time. This time will depend on work order priority as it can be measured daily, every three days, or weekly.

2.5.6. Average time taken to respond to a maintenance call

Calculate the average time taken to respond to any breakdown. This helps in measuring the responsiveness of maintenance department toward any service needed.

2.5.7. Average time taken to clear a minor breakdown

Calculate the time taken to rectify any problem that is classified as (minor). This will measure the performance of maintenance team in doing the work.

2.5.8. Average time taken to clear major breakdown

Calculate the time taken to rectify major breakdown that may cause any or all airport operations to be stopped. This indicator shows the effectiveness of maintenance department in responding to any serious faults that affect the whole system.

2.5.9.Number of repeated maintenance work

Indicate the number of repeated maintenance work done for specific equipment monthly, semi annually, and annually. This will show the status of the equipment over the time to help in any decision making for replacing or repairing equipments.

2.6. Airport Operations Performance Measures

The move toward privatization in many airports around the world raises the need to assess and improve the performance of its operations to become productive, efficient, and cost effective businesses. For that reason, it's essential for this type of airports to have effective performance measurement indicators to help reaching its goals and objectives. As this area of research is huge, this literature review will focus only on the performance indicators that measure the airport operations performance in terms of services

that affect passengers only. Following are the performance measures that this report will highlight in order to measure the airport performance.

2.6.1. Passenger's Services Performance Measures

These types of indicators measure directly the performance of processes and services being provided to the passengers. In other words, these indicators are given high values by the airport authorities as passenger satisfaction may be considered to be the ultimate goal of many of them. Following are some of these performance measures that can be used in airports:

2.6.1.1. Passenger's Processes Performance Measures

This group of indicators represents the time consumed by passengers in various processes within the airport. These types of indicators are lagging indicators as it depends on several factors. This group consists of:

- **Baggage claim time:** calculates the total time taken for all passengers in each flight to claim their luggage. This type of indicator is measured by minutes per flight.
- **Passport Control time:** measure the time taken for each passenger to finish the passport control procedures. This indicator is measured by minutes per passenger.
- **Check-in time:** calculates the time taken to finish the check-in process in minutes per passenger.
- **Security checks time:** the time consumed by each passenger in the airport security check and inspection process.

2.6.2. Passengers Comfort Indicators

These indicators reflect the passenger's satisfaction on the utilities and public services of the airport. This may include satisfaction over HVAC, lighting, lifts, escalators, toilets, hallways, lounges, etc. This type of measure is collected using satisfaction surveys over a random number of passengers.

2.6.3. Airport Management Performance Measures

This group of indicators represents the measure of various activities among the airport. The following indicators will focus only on those being affected either direct or indirect by any technical failures or maintenance work. These indicators are:

- **Availability of System/Process:** measure the availability of each process that passengers are passing through within the airport facility. This can be calculated using the backlog of the maintenance department.
- **Number of passengers currently under process:** measure the number of passengers those are currently being processed in every process (like check-in, security, etc.). It is hard to have these indicators instantaneously so it can be taken as a snapshot on random times during the day.
- **Number of passengers processed:** this measures the number of passengers processed in every process (like check-in, security, etc.). This can be calculated daily, weekly, monthly, and yearly.
- **Gate/Lounge utilization:** represent the percentage of utilization of every gate/lounge during the day, week, month, and year.
- **Number of flights handled:** represent the total number of flight handled per day, week, month, and year.

- **Total flight delayed > 15 min due to technical fault:** represent the number of flights that had been delayed over 15 minutes due to system/ equipment failure. This can be measured for day, week, month, and year.
- **Percentage of flights delayed of the total flights delayed:** represents the number of delayed flight among the total delayed flight number.
- **System/ equipment utilization:** show the utilization of various systems/equipments in the airport. This may include baggage scanners, security check, boarding jet ways, etc.

2.7. The Airport Maintenance Department

Maintenance became a major player in the success of any organization. The airport maintenance department undertakes the responsibility of keeping the airport a live at its full load whenever needed. Airports are mainly divided into two areas, landside and airside. The airside includes all the area beyond the terminal's building including jetways, taxiways, runways, etc. The landside area consists of terminal building, transportation stations, and parking areas. This research will focus on the role of maintenance at the airport's landside only.

2.7.1. The Role of Maintenance at an Airport

At every airport, the role of maintenance is different depending on many factors such as airport size and capacity. The main responsibilities for maintenance department within airport landside are maintaining:

- Building Electrical, including:

- HV/MV/LV power supply
- Uninterrupted power supply (UPS)
- Standby power generators
- 400 Hz power

- Building Mechanical, including:

- HVAC
- fire protection
- plumbing
- Potable Water Network
- Sewage and drainage network

- Building low current systems including:

- SCADA
 - Intercom
 - telephone
 - building automation system
 - fire alarm system
 - data cabling network
 - HVAC control
 - Master Clock
- Fire Fighting Systems
 - Terminal Building and Car Park Custodial
 - Terminal Roads and Grounds
 - Terminal Low current Systems
 - Fire extinguishing systems

- Baggage Handling System

All of the systems mentioned above are examples of what may be found at any airport. The role of maintenance though is to ensure that all the airport systems are reliable enough to perform its function whenever requested to do.

2.8. The Airport Maintenance Strategy

The strategy of keeping an airport up and running differ depending on the airport size, capacity, and traffic load over the year. One of the winning maintenance strategies that are being used in many airports is Reliability Centered Maintenance (RCM). The RCM ensures high reliability of airport processes and systems that can be used in busy and congested airports. Following is review on RCM philosophy and strategy.

2.8.1. Reliability Centered Maintenance

Reliability centered maintenance (RCM) is “a systematic process used to determine what has to be accomplished to ensure that any physical facility is able to continuously meet its designed functions in its current operating context”. The RCM helps in quantifying best practice maintenance management strategy that consider operational, economical, and safety efficiency and effectiveness. The goals of RCM are to:

- Achieve an ultimate level of reliability and safety
- Collect useful information and data to enhance the design for improving the reliability
- Design the required priorities to assist preventive maintenance
- Achieve these goals with the minimum cost

2.8.2. RCM Elements

The RCM is a combination of different maintenance types. These types of maintenance are redefined to be aligned with RCM concept. The main elements of RCM are:

2.8.2.1. Corrective Maintenance

In this type of maintenance, actions are only taken when a fault occur lead system/equipment to stop functioning. It can be applied if the cost of failure and risk of a corrective action is less than performing a preventive action, or if no preventive action can be taken solve the problem.

2.8.2.2. Preventive Maintenance

Preventive maintenance is one the important elements of RCM due to its direct effect on the reliability. Even though, it cannot be the main and only element used in maintenance as it costs a lot to apply this method in terms of money, effort, and time. The preventive maintenance actions or activities include :

- Condition Based Actions

This type of actions is based on regular monitoring of a system/equipment to notice any sign of failures or deteriorations. This type of failure can be detected physically and/or by reading and sensing devices to know if it will happen or already happened.

- Scheduled Restoration Actions

In scheduled restoration actions, pre-scheduled tasks are performed to set an equipment/system back to its original status. In this type of actions, the item is placed out of service to conduct certain checks and perform corrective action of needed.

- **Scheduled Replacement Actions**

This type of actions is conducted to replace certain piece of an equipment/system as recommended previously. The preventive replacement actions always related do small items while normally big items may be restored.

- **Proactive Maintenance**

Proactive maintenance is method to improve maintenance performance through initial design and maintenance processes. This method analyzes the cause of the problem from its roots and its possibility of occurrence then tries to solve it. The aim of proactive maintenance is to “enhance maintenance effectiveness, conducts periodic evaluation of the technical content and performance interval of maintenance tasks, integrates functions with support maintenance into maintenance program planning, and uses a life cycle view of maintenance and supporting functions” .

Following are the proactive maintenance actions that may be applied:

1. Reliability Engineering: The reliability engineering is focused on redesign, improve, or modify part/component to increase system/equipment reliability.

2. Failed Item Analysis: This is done physically by removing the defected item to analysis the cause of failure. Additional technical investigation may be done to find the source of failure if applicable.

3. Root Cause Failure Analysis: This analysis is used to find the cause of the problem effectively and repairer it with the attitude of “fix forever”.

4. Specifications for New or Rebuilt System/Equipment: to set a high standards or specifications that ensure high reliability in any attempt to buy or re-new a system or equipment.

5. Verification of functioning: to make sure that the system or equipment is functioning according to the standards in the commissioning and installation phase.

6. Recurrence Control: to keep an eye on the repetitive failures that occurred and caused the system/equipment to fail.

The implementation of RCM program in a busy airport will help improving the quality of services offer but it must bear in mind the cost effectiveness of applying such strategy versus the benefits that will be gained.

2.9. Balanced Scorecard (BSC)

There is a significant amount of literature that is dedicated to the concept of a balanced scorecard which is a tool for measuring performance. Kaplan (2010) indicates that the principle concept that underpins the use of BSC is the realization that measurement precedes understanding. In this view, Kaplan argued that one cannot comprehend something without first measuring it. Initially, the BSC was only adopted as a tool for measuring tangible aspects of performance. In this view, the tangible assets of an organization are solely used to measure organizational performance. However, research that was done indicated that intangible assets also play an important role in determining organizational performance. These findings emphasized that performance measurement should include value created through both the tangible as well as the intangible assets of a firm (Kaplan, 2010). According to Kaplan et al., (2001), BSC aims to measure four key performance metrics which are the financial, internal processes, the customer, and growth. Madsen & Steiheim (2014) state that the financial metrics are vital for ascertaining whether the organizational strategy is being implemented in a manner that is consistent with the overall mission of the business. In respect to Private or profit-driven organizations, the financial metrics aim at measuring profits and the existing market share. Conversely, in non-profit organizations, financial metrics are about outcome-oriented processes (Madsen & Steiheim, 2014). BSC also determines the customer perception

of the service provided. Casey & Peck (2004) observe that understanding Customers' perception is important as it affects sales and revenue. In this view, high positive perception is associated with an increase in sales and generated revenue. In relation to the customer, therefore, BSC examines metrics such as quality and service performance. Internal processes with respect to BSC focus on aspects that improve innovation and staff skills (Kaplan, 2010). According to Marntinsonet et al. (1999), BSC is a tool for making more informed strategic decisions. In this view, BSC acts as an instrument for transforming strategy to actual performance measures and aligning it with the wider mission of the organization. It also performs as a tool for goal setting and allocating organizational resources. BSC also identifies activities that are lurking in execution and areas that need more resources or lack enough skills or knowledge (Basu et al, 2009). However, while the adoption of BSC is wider, studies show that not all organizations are successful in employing the performance measurement tool (Casey & Peck, 2004). It is within this perspective that Parida, Ahren, and Kumar et al., (2013) say that the proper way of adopting BSC is to align it with the goals of the organization or the department.

3. Methodology

3.1. The Performance Measuring Model

The performance measuring model needs to be especially designed to match the situation in the maintenance department. In addition, it needs to be customized in a way that help meeting this research goal's to measure the impact of maintenance performance on maintenance department. For these reasons, the core step of this research is to find the best match performance measures for both airport operation and maintenance then find the most accurate link between both types to ensure the accuracy and significance of the results.

3.1.2. Maintenance Performance Measures

The steps for preparing the model are to choose the most suitable performance indicators for the maintenance department that can be used to evaluate the maintenance activities during the peak season. The indicators that are going to be used in this research for maintenance activities will cover preventive and corrective maintenance measures, and various terminal processes systems indicators. The following table is showing the indicators that could be used in this research:

Table 3.1: Maintenance Performance Indicator

<i>Indicator</i>	<i>Type</i>
Total Service calls received during the season	GM
Avg. service calls per day	GM
% of Technical complains	GM
% of Operational complains	GM
Average time taken to respond to a maintenance call	GM
Work orders	GM
Total issued work orders	GM
PM WO/ total maintenance WO	GM
CM WO/ total maintenance WO	GM
Total issued work orders	PM & CM
Total approved WOs	PM & CM
% of completed WOs	PM & CM
% of non-completed WOs	PM & CM
% of non-completed WOs due to unavailability of spare parts	PM & CM
% of non-completed WOs due to unavailability of equipment	PM & CM
% of PMs work order open after 6 days	PM & CM
% of Pending WOs	PM & CM
Avg. WOs downtime for each system	PM & CM
% of satisfactory WOs	PM & CM
% of WOs require rework	PM & CM
% of completed CMs during - 10 min - 20 min - 45 min - > 1 hr	CM
% of major breakdowns	CM
% of minor breakdowns	CM
Average time taken to clear minor breakdown	CM
Average time taken to clear major breakdown	CM

3.1.3. Hajj Terminal Operation Processes Performance Measures

In measuring the HT operations performance, many factors are involved within these areas. These factors can include passengers' movements, safety procedures, availability of staff, and availability of equipment and systems. To be more focused, specific terminal operation processes will be selected in order to measure its performance during the season of 2019. The processes that will be examined in this research are:

1. Baggage Claim
2. Passport Control
3. Check-in
4. Security Checks & Inspections

For the above mentioned processes, the factors that may affect each one of them including maintenance performance must be listed and weighted in order to study the actual effect of maintenance on terminal operations. This task is going to be done using a questionnaire that will be answered by Hajj terminal management.

3.2. Data Collection

The core of any successful research project is the type and the way that data being collected. Inaccurate data can easily mislead people, cause the research to fail, or even it may lead to a disaster. For this reason, the data collection plan for this research is divided into three elements: time, methods, and sources.

3.2.1. Collection Time

As Hajj Terminal is an extraordinary airport terminal in terms of design, operation and load distribution, the data needed in this research will be collected only during the season 2019.

3.2.2. Collection Methods

The methods used in collecting data for this research are qualitative and quantitative. The quantitative ones are mainly used in gathering data for performance indicators while the qualitative tools were used in the questionnaire filled by terminal management.

3.2.2.1. Quantitative Data

The quantitative data mainly includes the record of any maintenance related data that will be used in this research. This can be divided into two parts: time and frequency. For the timely data, this include the time elapsed i.e. performing preventive and corrective maintenance, down time, delays, etc. For the frequency, this can include number of failures of a machine during day, week, and month. The source of gathering these data will be from maintenance terminal database, computerized maintenance management system, and field data collection. This type of data will clearly represent the current situation of the maintenance activities and will show the areas that need to be considered as a strength or weakness.

3.2.2.2. Qualitative Data

The qualitative data is the one which cannot be recorded or measured precisely as it is based mostly on personal opinions, experiences, and knowledge. This type of data can be collected by several methods including interviews, questionnaires, and surveys. In this research, a survey will be made in order to give a percentage for the maintenance performance as a factor affecting the various terminal operation processes among other factors. This survey will be completed by chief operations officer, terminal duty managers, and airport controllers.

3.3. Limitations of this Research

As of any scientific study, usually researchers face a number of issues and limitations during the research. This research had faced a number of problems. One of the most critical problems is that the literature on the area of airport maintenance and management is very limited and hard to find. Their resources of data in this field mainly are not published to the public. Therefore, the research tried to merge and modify the literature available to answer the research question.

In addition, there was no any performance measurements data for airport maintenance activities available (based on the available resources) to be used as reference or benchmark in this research. This added more challenges to complete this research and get valuable information out of it at the end. The time limitation was also another critical issue as this study was related to Hajj terminal operations during only one year. This issue also added more time constraints to this research.

Another limitation to this research is that it was not possible to examine all the maintenance activities in Hajj terminal as it is a vast and huge place that can't be covered in a Master's degree research. In relation to issue, not all the terminal operations was studied in order to find the effect of maintenance activities on it as there are more than 15 different processes within the Hajj terminal. The most common and related maintenance activities and operational processes had been taken into account to establish this research.

4. Results

4.1. Customer Satisfaction Indicators

4.1.1. Passenger Satisfaction Score

In order to collect the data for these indicators first the customer of the maintenance department needs to be identified. PAX of hajj terminal is considered a major customer for the maintenance department at hajj terminal. A survey was conducted to measure the satisfaction of passengers by a specialized company.

Objective

To reach highest Passenger Satisfaction Score

Measures

Facilities & Amenities (20%)

- Ease of finding your way through airport (signage)
- Availability of information desks
- Ease of finding seats in the departure lounge (outbound passengers only)
- Accuracy and ease of finding information about your flight?

Ambience & cleanliness (20%)

- Cleanliness of this airport terminal
- Cleanliness of washrooms
- Comfort of waiting/gate areas
- Cleanliness of airport prayer rooms

Arrival / departure services (20%)

- Availability of baggage trolleys
- Efficiency of check-in(outbound passengers only)
- Efficiency of passport control (immigration)
- Efficiency of customs control (inbound passengers only)

Staff (20%)

- Courtesy & helpfulness of check-in staff (outbound passengers only)
- Courtesy and helpfulness of passport & customs control staff
- Courtesy & helpfulness of security (outbound passengers only)

Waiting Times (20%)

- Overall Satisfaction with total waiting time at airport

Calculation

The calculation is done by taking the average of each question and then calculate the overall average through this formula:

$$Ave = \frac{1}{n} \sum_{i=1}^n ai$$

A= arithmetic mean

n= number of vaules

a_i = data set values

Target

The score of 2019 is 88.4%

Goal is to reach at least 92%

Initiatives

The initiatives were taking in consieration is

- Increasing the number of weekly inspection visits to the site
- Reduce the wait time for customer by reducing the failure time in the systems

4.1.2. To meet General Authority of Civil Aviation Service quality standards

Another important indicator for the maintenance department is the General Authority of Civil Aviation Service quality standards. This will help to see if the maintenance department is following the standard made by the General Authority of Civil aviation in the BTO (Build to operate) contract.

Objective

To meet General Authority of Civil Aviation Service quality standards

Measures

Processing Facility (30%)

- Waiting time at check- in for passengers
- Waiting time at security control for passengers
- Waiting time at outbound passport control
- Waiting time at customs control
- Waiting time at baggage collection (first bag)
- Waiting time at baggage collection (last bag)

Passengers Experiences (30%)

- Overall passenger satisfaction with airport services
- Satisfaction with airport cleanliness
- Satisfaction with airport information
- Satisfaction with airport seating
- Satisfaction with airport baggage carts
- Satisfaction with airport Wi-Fi

- Satisfaction with vehicle parking

Asset Availability (15%)

- Availability of passenger sensitivity equipments
- Availability of baggage handling system

Other Key Areas (15%)

- Delays caused by airport operator

PRM (Persons with Reduced Mobility) (10%)

- PRM assistance time - departures
- PRM assistance time - arrivals

Calculation

First for Processing Facility

The observer monitors passengers approaching each processing facility and start by taking out start time and end time. After taking the times, calculate the average wait time for each factor. Then create a category table so the time can be converted to a 5 points scale

1 point	< 20 min
2 points between	20 min to 16min
3 points between	15 min to 11 min
4 points between	11 min to 6 min
5 points between	6 min to 0.1 min

For all the other elements. A 5 points scale servuy conduct by the supervisor to evaluate the situation of the site.

Target

Current 4.17 points out of 5 points

Goal is 4.5 points out 5 points

Initiatives

- Decrease the wait time by adding more check-in counters
- Reduce the failure time of baggage handling system by increase PM for the BHS

4.2. Internal Procoess Indicators

4.2.1 PAX' System Availability indicator

There are 6 major systems that can affect passengers' processes directly. Any delay at any of the systems can cause delay in passengers' process. checking the availability of these systems can help to measure how ready the systems are.

Objective

To measure availability of PAX' process systems

Measures

- Jetways (16%)
- Carusel mobile counter (16%)
- Check-in counter (20%)
- Carusel X-ray(16%)
- BHS X-ray (16%)

- Lounges X-ray(16%)

Calculation

The formula used to calculate the availability of the systems is
Availability = uptime ÷ (uptime + downtime)

Target

Current 94.1%
Goal 97 %

Initiatives

- Open a new ware house near check-in area to make spare part available in short time.
- Increase number of technicians the shift to cover all the complain faster

4.2.2. Overall intern process indicator

In this indicator, it was focused on the department internal process. Every process inside the department is measured through different prospective,

Objective

To measure all the intern process

Measures

- Attending Meeting
- Progress in maintenance Activities
- PPM task to be completed
- CM to be completed on priority task
- Submit Monthly PM from Annual Master Plan
- Submit Maintenance Activity Plan
- Submit daily attendance sheet
- Shortage of manpower
- % of system availability
- % of spare parts availability
- Submit Minimum Stock level
- Initiate maintenance activity without approved WO
- Completion of WO within approved time
- Backlog of Deferred Work
- % of completion complain within approved time
- Maintenance Work Quality
- Avg. response time
- Avg. time to repair
- Submit Equip./Tools list
- Submitting system Status reports
- Submitting Maintenance Reports
- Risk Assessment Compliance.
- Compliance with HSE regulation.
- Monthly Report for Energy Management
- Compliance with HSE
- Availability of Spares and Consumables
- Compliance of maintenance tasks as per Operation and Maintenance Manual and or in a Good Industry practices

Calculation

In the following table there is the method used to calculate the score of each KPI

Item #	KPIs	Description	Indicator	Target	Measurement
1	Management	Management Meeting, Operational Structure Resource Plan	<ul style="list-style-type: none"> - Attending Meeting in - Progress maintenance Activities 	Exceptional Performance = 95% Good Performance = 80-94% Poor Performance = 75-79% Unacceptable Performance = <74%	Rating Scoring /
2	Maintenance	PPM Program Reactive Maintenance Technical Library Maintain Emergency System Spare Parts Availability Uniforms	<ul style="list-style-type: none"> - PPM task to be completed - CM to be completed on priority task 	Exceptional Performance = 95% Good Performance = 80-94% Poor Performance = 75-79% Unacceptable Performance = <74%	Rating Scoring /
3	Operation and Maintenance Plan	Full detailed plans to be submitted to Maintenance Dept. for approvals. Any changes to the approved plan Contractor shall review it with the Maintenance Dept.	<ul style="list-style-type: none"> - submit Monthly PM from Annual Master Plan - submit Maintenance Activity Plan 	Yes-5 No-0	Rating Scoring /
4	Manpower Attendance	The Contractor shall provide the adequate labour force at the site accordance to the performance requirements.	submit daily attendance sheet Shortage of manpower	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating Scoring /
5	System Availability	The Contractor shall confirm the availability and readiness of the systems as per the scope of work.	% of system availability	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating Scoring /
6	Spare Part Availability	The Contractor has to maintain the minimum stock level and to submit the recommended spare parts' list to Maintenance Dept. at the beginning of each year based on life cycle and manufacture recommendations.	<ul style="list-style-type: none"> - % of spare parts availability - Submit Minimum Stock level 	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating Scoring /
7	Work Orders	W.O to be issued prior to work and shall involve all concerned departments	<ul style="list-style-type: none"> - Initiate maintenance activity without approved WO 	>95% - 5 90% < 95% - 4 85% < 90% - 3	Rating Scoring /

		and their approval. The work has to be complete within the approved time.	- Completion of WO within approved time	80% < 85% - 2 75% < 80% - 1 <60% - 0	
8	Quality Service of	The Contractor shall establish a quality control program to ensure works comply with standards	- Backlog of Deferred Work - % of completion complain within approved time - Maintenance Work Quality	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating / Scoring
9	Response Time	Response time starts from Maintenance Dept. first call to the technician presence at the specified equipment.	Avg. response time	Avg. Min/call (per call type)	Rating / Scoring
10	Time to Repair	The time required to complete the work and need to be within the time frame.	Avg. time to repair	Avg. Min/incident (per maintenance Level required)	Rating / Scoring
11	Equipment and Tools	The Contractor shall have all necessary equipment and tools to perform his work at site as per the manufacturer's recommendation and to maintain a set of measurement and calibration tools to test the equipment under his scope of work.	- submit Equip./Tools list - % of availability	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating / Scoring
12	Reports Submission	All maintenance reports Ex. (corrective, monthly and annually) reports need to be submitted when it's required and to be in computer-based format.	- Submitting system Status reports - Submitting Maintenance Reports	>95% - 5 90% < 95% - 4 85% < 90% - 3 80% < 85% - 2 75% < 80% - 1 <60% - 0	Rating / Scoring
13	HSE	Risk Management Health & Safety Plan Energy Management Plan Comply with HSE Operational	Risk Assessment Compliance. Compliance with HSE regulation. Monthly Report for Energy Management Compliance with HSE	Exceptional Performance = 95% Good Performance = 80-94% Poor Performance = 75-79% Unacceptable Performance = <74%	Rating / Scoring
14	Materials	Store & Stock	Availability of Spares and Consumables	Exceptional Performance = 95% Good Performance = 80-94% Poor Performance = 75-79%	Rating / Scoring

				Unacceptable Performance = <74%	
15	Non Schedule Maintenance	Corrective Maintenance	Compliance of maintenance tasks as per Operation and Maintenance Manual and or in a Good Industry practices	Exceptional Performance = 95% Good Performance = 80-94% Poor Performance = 75-79% Unacceptable Performance = <74%	Rating Scoring /

Target

Current 3.7 out of 5

Goal 4.2 out of 5

Initiatives

- Motivating sections to send reports on a regular basis
- Raising the efficiency of the section's reports by adding an evaluation of the section heads reporting

4.3. Financial Indicators

4.3.1 General Department Expenses

Maintenance department has many expenses. One of the most important expenses is the general expenses. General expenses cost a significant amount each year.

Objective

To reduce general expenses

Measures

- Office Stationery and Supplies Expenses
- Utility Expenses
- Telephone Expenses
- Insurance Expenses
- License Expenses
- Payroll Expenses
- Vehicle Expenses
- Travel Expenses
- Other Expenses

Calculation

Every element was tracked for the year 2019 and calculate the total of cost.

Target

Current 3,450,388 SAR

Goal 3,350,388 SAR

Initiatives

- Go Paperless
 - Compare providers
- Eliminate unnecessary expenditure

4.3.2. Measure & Manage Spare Parts Inventory

Objective

To increase the efficacy of spare part managements

Measures

- Inventory accuracy (45%)
- Money spent on emergency purchases compared to overall purchases (20%)
- Days of inventory on hand (20%)
- Back orders and vendor performance (15%)

Calculation

- Inventory accuracy: *Actual count/Computer reported on-hand balance.*
- Money spent on emergency purchases compared to overall purchases: *Emergency money spent on purchases / Total money spent on all purchases*
- Days of inventory on hand: *Total inventory valuation/Average daily money used*
- Slow-moving parts: Number of parts identified as slow or no movement/ Total parts in inventory.

Target

Current 2.87
Goal 2.5

Initiatives

- To go paperless & computerized all the transaction.
- To focus on the disposal of unused parts
- To double check by outsourcing auditor

4.4. Learn & Growth Indicators

4.4.1. Team's efficiency Indicator

Objective

To reduce the average time for task completion

Measures

- Time for task completion
- Number of times performed

Calculation

$$= \frac{\text{Total time to complete the same task (across set timeframe)}}{\text{number of times performed}} \times 100$$

Target

Current 75 %
Goal 80%

Initiatives

- Schedule weekly meeting
- Providing a complete tool bag for the technicians
- Reorganize technicians' room location

4.4.2. Employee training Indicator

Objective

To increase employee training satisfaction rates

Measures

- Quality of the Training (20%)
- Relevance of Training to the current Job (20%)
- Training effective on improve employee' performance (20%)
- Need for Further Training (20%)
- Effects of Training on Motivation of Employees (20%)

Calculation

Taking the average of all answers after multiplied them in 10

Target

Current 85 %
Goal 90%

Initiatives

- Find higher quality training course provider
- Increase the yearly number of provided courses

5. Conclusion

Finally, The balanced scorecard shows the company how well it's managing its strategies. In this thesis, it was shown indicators of airports. This study created the balanced scorecard for the maintenance department of King Abdulaziz International airport. 8 key performance indicators were invented. Two regarding customer satisfaction. Another two internal process indicators. Last four were financial, learn and growth indicators. All the indicators calculation were explained. Now the maintenance department of King Abdulaziz International airport is able to determine and measure its action to achieve its vision.

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