SAINT MARY's UNIVERSITY COLLEGE

SCHOOL OF GRADUATE STUDIES

ASSESSING THE PREVENTIVE MAINTENANCE PRACTICE AT SHERATON ADDIS

BY
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DECEMBER, 2017

ADDIS ABABA, ETHIOPIA

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ABBRIVATIONS

BM- Breakdown Maintenance

CM- Corrective Maintenance

CMMS- Computer Maintenance Management System

MM- Maintenance Management

PM- Preventive Maintenance.

PdM- Predictive Maintenance

RCM- Reliability Centered Maintenance

SMMSM- Sheraton Maintenance Management System Manual

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ABSTRACT

Performing preventive maintenance is always the best long-term strategy to maintain equipment. A result-oriented hotel must then successfully tackle these challenges in the most effective manner possible. This study was designed to assess the preventive maintenance practices and identify availability of full resources, machine and equipment inventory, efficiency of computer maintenance management system and strict implementation of preventive maintenance program at Sheraton Addis luxury collection hotel. This study adopted a descriptive survey research design. The organization has total population of around 750 employees in 11 departments. From 11 departments, the researcher considered four departments namely; engineering, housekeeping, food preparation and stewarding using purposive sampling technique. The total population of these selected four departments was 275.The study sample was 163respondents which consists of engineering management which is the policy makers, engineering non-management which is executer and user department of the preventive maintenance program. Questionnaires were the main data collection instruments and interview was held with the chief engineer of the hotel. Data was classified, edited and analyzed. The major findings are most the engineering management believe that there are available resources, complete machine and equipment inventory, computer maintenance management system is efficient and the total preventive maintenance program is effective while the engineering non-management and user department don't agree. Finally the study recommends that management should provide adequate spare part available for preventive maintenance, computer maintenance management system needs to be upgraded and the hotel must give an attention on training.

CHAPTER ONE

Introduction

1.1 Background of the study

Each year around the world billions of dollars are spent on equipment maintenance, and since the industrial revolution, maintenance of engineering equipment has been a real challenging issue. Over the years remarkable progress has been made in maintaining engineering equipment in the field, but it has still remained a challenge due to factors such as complexity, size, competition, cost, and safety (Unger et al., 1994).

Before World War II there was no maintenance as much. Parts were mostly menial and they would break so they were changed thus removed. An error, therefore, had little effect and was in many cases thus ignored. That changed during the war. Demand for production and production increased, but with a lack of manpower it led to more mechanized industry and more complex production (Alsyouf, 2007). Cost, longevity and availability were topics that aroused interest, and thus arose maintenance departments. The new found state had maintenance departments to develop periodic maintenance, planned maintenance and preventive maintenance (Kister and Hawking, 2006). Successful companies of today have often a distinct expressed business idea connected to a strategy that explains it and also, how to reach it.

It is widely known that maintenance previously is viewed by management as a big expense. And it is not an unusual opinion since maintenance does not include any value adding activities. But this is about to change. It is increasingly common for enterprises to work with maintenance as a center point of profit. A greater knowledge of maintenance and its ability for long term profiting have increased the interest in the topic. It is all based on minimizing the downtime and the key to success is to ensure that proactive maintenance is properly being used. Hence, by leaving the firefighting perspective and striving to use proactive maintenance there is a lot to gain. Less failure, minimized downtime, lowered stress and higher quality, all working in the favor of profit (Alsyouf, 2007).

The manufacturing facilities became even more automated and complex during the 1970s (ibid). Reliability, availability and maintainability, as well as quality, safety, environment and multi-skilling were now considered very important. Condition monitoring, condition based maintenance and

maintenance management information systems began to be used in the industry. Condition based monitoring became easier to use in industry due to automation and development in information technology, and maintenance became more integrated and was no longer an isolated function (Alsyouf, 2007).

The middle and corporate level management have until recently, ignored the impact of the maintenance operation on production costs, bottom-line profit and product quality. The general opinion has been that "nothing can be done to impact maintenance costs" or "maintenance is a necessary evil". The developments of computer-based instrumentation or microprocessors have provided the means to manage the maintenance operation due to that it can be used to monitor the operating condition of plant equipment and systems. Unnecessary repairs can with this technique be reduced or even eliminated, catastrophic machine failures can be prevented and the negative impact of the maintenance operation on the profitability can be reduced (Mobley, 2004).

It was not until recently that maintenance has gained recognition as potential profit generator. This is, despite the fact that in many industries maintenance amounts for a substantial sum and the maintenance personnel sometimes comprises a significant number of the total work force (Waeyenbergh and Pintelon, 2002).

The focus today is, due to globalization, to create internal and external partnership between maintenance and other elements in the supply chain, for example are maintenance involved when designing and improving the production process, and helping the purchasing department to select the original equipment manufacturer. Monitoring the deviations in both the quality of the product and the machine condition are now more emphasized (Alsyouf, 2007).

An increasingly number of companies replace the current reactive, "fire-fighting" maintenance strategy with proactive strategies such as predictive and preventive maintenance and also with aggressive strategies such as Total productive maintenance in order to achieve world-class performance (Swanson, 2001).

Companies undertake efforts to reduce costs and at the same time improve quality and productivity, a part of these efforts commonly includes an examination of the maintenance function. For many operations within a producing company are effective maintenance critical due to the fact that it extends equipment life, increase equipment availability and retains equipment in proper condition. Poorly maintained equipment may conversely lead to more frequent failures of the equipment, low utilization rate of the

equipment and delayed production schedules. Equipment that is malfunctioning or misaligned may cause a higher scrap rate or produce products with a questionable quality. In addition does the equipment need to be replaced more often due to shorter life-cycles, which also is a consequence of poor maintenance (Swanson, 2001). Maintenance has traditionally been considered as a necessary evil, but it is in fact rather a center of profit than just unavoidable and unpredictable expense (Alsyouf, 2007). If effective maintenance policies are used, failures can be reduced to a minimum level which can result in great savings. Therefore, due to its role in the corporate long-term profitability, more and more significance is put on maintenance. The production and its operational aspects such as quality, costs, capacity, safety and environment are influenced by maintenance of the equipment.

Since Sheraton Addis is conducting its business in a hospitality industry and this industry strongly rely on customer satisfaction, preventive maintenance can help the hotel to provide customers with better customer service. Because preventive maintenance enhances equipment functioning, the hotel can offer its customers more reliable service and acquire a very good reputation which leads to high profit.

1.2 Statement of the problem

Preventive maintenance is required for many machines and equipment to ensure they run at maximum efficiency. The phrase preventive maintenance refers to a complete program focused on keeping all machines and equipment at utmost efficiency.

According to Swanson (2001), some benefits of preventive maintenance are:

- ✓ Machines will work at full efficiency
- ✓ Problems are recognized earlier
- ✓ Extended Lifetime of machines.
- ✓ Reduces the chance of emergency repair calls.
- ✓ Reduces downtime to locate and replace missing parts.
- ✓ Saves money on energy.
- ✓ Reduce insurance rates since well-maintained machines are much safer.
- ✓ Reduces late deliveries that may occur due to downed machinery.
- ✓ Preventive Maintenance Enhances Customer Service and Reputation.

To implement effective preventive maintenance program the following factors are necessary:

1. **To have the right resources.**

The availability or non-availability of physical resources affects decisions in that, when suitable materials for maintenance are not available, it becomes difficult to undertake maintenance. Again even if suitable materials are available but not in adequate quantities and the alternative materials are not available, it will deter people from undertaking maintenance activities. The level of craftsmanship in terms of both skills and efficient numbers can also affect decisions to carry out maintenance.

2. **Inventory**

As stated by Moubray (1997), all the equipment and create a list of all the assets which needs preventive maintenance. This information will help:

- To develop preventive maintenance instruction.
- Prioritize machine.
- Identify machines with common spare parts.
- Track costs and help determine whether a piece of equipment needs to be replaced.
-

3. **Using computerized maintenance management system (CMMS).**

With CMMS you have the ability to create customized procedures, tailored for your particular company. The computer system automatically calculates estimated time for your preventive maintenance tasks, updating and tracking the average time and cost for completing each task. Plus, with all data stored in one place, you can more effectively manage work orders, purchase orders, inventory, and maintenance records (Sheraton maintenance management system manual, 2013).

Poorly maintained equipment conversely lead to more frequent failures of the equipment, low utilization rate of the equipment and delayed production schedules. Equipment that is malfunctioning or misaligned may cause a higher scrap rate or produce products with a poor quality. In addition does the equipment need to be replaced more often due to shorter life-cycles, which also is a consequence of poor maintenance.

Moreover, preventive maintenance system failure in hotel industry causes negative impacts to the users and customers. The negative impacts could be on the aspects of sales, safety, environmental integrity, system quality, customer satisfaction, and additional repair cost incurred (Sheraton maintenance management system manual, 2013).

Sheraton Addis is one of the hotels which implement preventive maintenance practice. It has its own preventive maintenance manuals which include policy and procedures of preventive maintenance standards. When the researcher observes (Has a work experience of 20 years) the preventive maintenance practice of the hotel and read the preventive maintenance manual, there is a gap between the manual and the actual practices of the hotel.

The gaps can be seen on lot of maintenance requests which are not planned and there is difficulty to track down all maintenance activities and to attend them on time.

To this end, the study was made to check the preventive maintenance management practices of Sheraton Addis Luxury Collection Hotel and answers the following research questions.

1.3 Research questions

The study aimed at answering the following questions:

- In Sheraton Addis, are there full resources to do the preventive maintenance program as per the manual?
- Is there a complete machine and equipment inventory in Sheraton Addis as the manual stated?
- In Sheraton Addis, is the entire computer maintenance management system effective as the manual instructed?
- Is the whole Sheraton Addis preventive maintenance program strictly implemented and controlled as per the standard operating procedure mentioned on the manual?

1.4 Objective of the study

1.4.1 General Objective

The general objective of this study was to assess the preventive maintenance management practices of Sheraton Addis hotel.

1.4.2 Specific objective

The study had the following specific objectives:

1. To assess the availability of full resources to do the preventive maintenance program at Sheraton Addis.
2. To examine if there is a complete machine and equipment inventory as the manual stated at Sheraton Addis.
3. To evaluate if the entire computer maintenance management system efficiency as per the manual at Sheraton Addis.
4. To assess strict implementation and control of the preventive maintenance program as per the standard operating procedure mentioned on the manual at Sheraton Addis.

1.5 Significance of the study

The study will have the following importance.

- The study could help the hotel to improve its preventive maintenance practice since it tried to find out the problem associated with the preventive maintenance practice in the hotel and proposes the possible solution.
- The researcher believes that such a research will serve as a spring board for other researchers who would like to study the same issue in a wider scale.
- The researcher used this opportunity and experience to build his knowledge and capacity to conduct further research.

1.6 Scope of the study

The scope of the research was to assess the preventive maintenance practices in Sheraton Addis Hotel.

The issues raised in the study are the availability of resources, machine inventory and computer maintenance management system to implement a good preventive maintenance management system at Sheraton Addis.

The organization has total population of around 750 employees in 11 departments. From 11 departments, the researcher taken four departments namely; engineering, housekeeping, food preparation and stewarding using purposive sampling technique. The total population of these selected four departments was 275.

The researcher chooses these departments because these departments are closely related to the subject matter of the study.

The study period consider the time from 2013 onwards. Because this was the time most machineries and equipment were replaced by new one.

1.7 limitation of the study

The first problems countered while doing the study is lack of ample reference books in the library. The second is the policy of the hotel which restricts gathering financial information from for personal use.

1.8 Definitions of operational terms

Breakdown maintenance: Repairs or replacements performed after a machine has failed to return to its functional state following a malfunction or shutdown (Alsyouf, 2007).

Computerized maintenance management system: is a software package that maintains a computer database of information about an organization's maintenance operations. This

information is intended to help maintenance workers do their jobs more effectively and to help management make informed decisions (Sheraton manual, 2013).

Engineering management: At Sheraton Addis, it is who formulate the policy and plan all the procurement, maintenance and operation of all equipment and machines (Sheraton manual, 2013).

Engineering non-management: In Sheraton Addis, it is hand on tools people (technicians) who do all the maintenance activities (Sheraton manual, 2013).

Maintenance: A combination of all technical and administrative actions carried out to retain an item in, or restore it to a state in which it can perform its required function(Alsyouf, 2007).

Predictive Maintenance: is first to predict when equipment failure might occur, and secondly, to prevent occurrence of the failure by performing maintenance. Monitoring for future failure allows maintenance to be planned before the failure occurs (Alsyouf, 2007).

Preventive maintenance: is one of the most common types of maintenance strategies used in different industries to prevent equipment from breakdown. The preventive maintenance actives are performed at regular intervals. The intervals can be based on fixed number of operation cycles, fixed cumulative outputs, calendar- based or number of operating hours(Alsyouf, 2007).

Reactive Maintenance It is basically the "run it till it breaks" maintenance mode. No actions or efforts are taken to maintain the equipment as the designer originally intended to ensure design life is reached (Alsyouf, 2007).

Reliability Centered Maintenance is highly reliant on predictive maintenance but also recognizes that maintenance activities on equipment that is inexpensive and unimportant to facility reliability may best be left to a reactive maintenance approach (Moubray, 1997).

User department: Departments who use machines and equipment in their day to day activity. In this study they are Housekeeping, stewarding, and food preparation (Own definition).

1.8 Organization of the study

The study was organized into five chapters. Chapter one deals with introduction. Chapter two focuses on literature review in preventive maintenance management. Chapter three deals with research methodology. Chapter four covers data presentation, analysis and interpretation. Chapter five tries to give summary, conclusions and recommendations. Finally list of bibliography and appendix were attached.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Background

Before World War II there was no maintenance as much. Parts were mostly menial and they would break so they were changed thus removed. An error, therefore, had little effect and was in many cases thus ignored. That changed during the war. Demand for production increased, but with a lack of manpower it led to more mechanized industry and more complex production (Alsyouf, 2007).
Cost, longevity and availability were topics that aroused interest, and thus arose maintenance departments. The new found state had maintenance departments to develop preventive maintenance (Kister and Hawking, 2006).

A production system consists of different types of equipment; all equipment must have a high availability and reliability in order to ensure a stable process. The maintenance department is responsible for keeping the equipment in the condition it initially was procured for and also to ensure that it can deliver according to the specification. This is an important role in a production system and if it is performed successfully it can facilitate the journey towards becoming sustainable through high asset utilization, thus providing to the overall profitability (ibid).

According to Lind &Muyingo (2009), maintenance is viewed by management as a big expense. And it is not an unusual opinion since maintenance does not include any value adding activities. But this is about to change. It is increasingly common for enterprises to work with maintenance as a center point of profit. A greater knowledge of maintenance and its ability for long term profiting have increased the interest in the topic. It is all based on minimizing the downtime and the key to success is to ensure that preventive maintenance is properly being used. Hence, by leaving the firefighting perspective and striving to use preventive maintenance there is a lot to gain. Less failure, minimized downtime, lowered stress and higher quality, all working in the favor of profit.

2.2 Meaning of Maintenance and preventive maintenance

Lind &Muyingo (2009) stated the meaning of maintenance as “restoring to or retain to a state in which an item can perform an initially specified function and all actions aimed towards this are maintenance activities”.

Maintenance is also seen as an investment because resources are spent today to do maintenance in order to reduce cost or get higher benefits in the future as compared to if the resources are not spent. However despite this opinion maintenance is generally separated from "true investment" because it is matter of restoring an old function or keeping up an old function (Lind &Muyingo, 2009).

British Standards 8210 (1986) defined maintenance as:" A combination of all technical and administrative actions carried out to retain an item in, or restore it to a state in which it can perform its required function".
The actions referred to are those associated with initiation, organization, and implementation. It envisages two processes: 'retaining', i.e. work carried out in anticipation of failure, referred to as 'preventive maintenance' and 'restoring', i.e. work carried out after failure, referred to as 'corrective maintenance'(Kister and Hawking, 2006).

Maintenance has also been defined as 'All actions taken to retain material in or to restore it to a specified condition. It includes inspection, testing, servicing, and classification as to serviceability, repair, rebuilding, and reclamation' (Collins English Dictionary, 2003).
It includes the routine recurring work required to keep a facility (plant, building, structure, ground facility, utility system, or other real property) in such condition that it may be continuously utilized, at its original or designed capacity and efficiency, and for its intended purpose (Dictionary of Military and Associated Terms, US Department of Defense 2005).

A more functional definition proposed by White (1969) is that 'maintenance is synonymous with controlling the condition of a facility so that its pattern lays within specified regions'. The word 'control' suggests a positive activity which is planned so as to achieve a defined end result while the term 'specified regions' presumably has a similar meaning to 'acceptable standards'. His definition envisages a range of acceptability with upper and lower limits between which the conditions of the facility must be maintained.
Maintenance therefore is all the necessary work done to preserve a facility with its furnishes and fittings, so that it continues to provide the same or almost the same facilities, amenities and serves as it did when it was first built (White 1969).

Preventive maintenance is one of the most common types of maintenance strategies used in different industries to prevent equipment from breakdown. The preventive maintenance actives (inspection, repair, replacement, etc.) are performed at regular intervals. The intervals can be based on fixed number of operation cycles, fixed cumulative outputs, calendar- based (may be in weeks, months or years) or number of operating hours (run time based) (Kelly,1997).

According to Alsyouf (2007), Preventive maintenance means the regularly scheduled repair and maintenance needed to keep a facility component operating at peak efficiency and extend its useful life. It includes scheduled activities intended to prevent breakdowns, such as periodic inspections, lubrication, calibrations, and replacement of equipment. Replacing filters in an air-handling unit on a regularly scheduled basis is an example of preventive maintenance. Because prolonging the life of major facility systems requires periodic replacement of equipment, preventive maintenance typically requires both capital and operating expenditures.

2.3 History of maintenance

The manufacturing industry did not have a high mechanical level before the Second World War, that is, most of the equipment was over-designed and simple. The consequences of failure did not have a strong influence and the effect was neglected. Due to this, the industrial equipment was running until failure occurred, and when it did it was either replaced or repaired. Thus the mentality was: “fix it when it breaks”. In the first approach of maintenance no actions were taken to detect the onset of failure neither to prevent failures, this approach can be described as reactive maintenance (ibid).

Alsyouf (2007) also mentioned the Second World War turned things around and everything changed dramatically during the war. This is due to shortage of manufacturing manpower and an increasing demand on production. As a result, the mechanization increased and the manufacturing facilities changed to be more complex.

To meet the growing demand for war materials, customer goods and to compensate to the manpower shortages, the technology within manufacturing was forced to develop more mechanization (Kister and Hawkins, 2006).

Cost, longevity and availability were now regarded as important factors to achieve the business objectives and therefore, maintenance was considered as a technical manner and became a task of the maintenance department (Alsyouf, 2007).

The manufacturing facilities became even more automated and complex during the 1970s. Reliability, availability and maintainability, as well as quality, safety, environment and multi-skilling were now considered very important. Condition monitoring, condition based maintenance and maintenance management information systems began to be used in the industry. Condition based monitoring became easier to use in industry due to automation and development in information technology, and maintenance became more integrated and was no longer an isolated function (ibid).

According to Alsyouf (2007), the middle and corporate level management have until recently, ignored the impact of the maintenance operation on production costs, bottom-line profit and product quality. The general opinion has been that "nothing can be done to impact maintenance costs" or "maintenance is a necessary evil".

It was not until recently that maintenance has gained recognition as potential profit generator. This is, despite the fact that in many industries maintenance amounts for a substantial sum and the maintenance personnel sometimes comprises a significant number of the total work force (Waeyenbergh and Pintelon, 2002).

The focus today is, due to globalization, to create internal and external partnership between maintenance and other elements in the supply chain, for example maintenance involved when designing and improving the production process, and helping the purchasing department to select the original equipment manufacturer. Monitoring the deviations in both the quality of the product and the machine condition are now more emphasized (Alsyouf, 2007).
Maintenance becomes more and more part of the integrated business concept and there is a growing trend towards outsourcing, also a shift from failure-based to use-based maintenance and increasingly towards preventive maintenance. Availability, reliability and safety in the production plants are now more emphasized (ibid).

The developments of computer-based instrumentation or microprocessors have provided the means to manage the maintenance operation due to that it can be used to monitor the operating condition of plant equipment and systems. Unnecessary repairs can with this technique be reduced or even eliminated, catastrophic machine failures can be prevented and the negative impact of the maintenance operation on the profitability can be reduced (Mobley, 2004).

2.4 Benefits of preventive maintenance

Companies undertake efforts to reduce costs and at the same time improve quality and productivity, a part of these efforts commonly includes an examination of the maintenance function. For many operations within a producing company are effective maintenance critical due to the fact that it extends equipment life, increase equipment availability and retains equipment in proper condition. Poorly maintained equipment may conversely lead to more frequent failures of the equipment, low utilization rate of the equipment and delayed production schedules. Equipment that is malfunctioning or misaligned may cause a higher scrap rate or produce products with a questionable quality. In addition does the equipment need to be replaced more often due to shorter life-cycles, which also is a consequence of poor maintenance (Swanson, 2001).

According to Alsyouf (2007), maintenance has traditionally been considered as a "necessary evil", but it is in fact rather a center of profit than just unavoidable and unpredictable expense. If effective preventive maintenance policies are used, failures can be reduced to a minimum level which can result in great savings. Therefore, due to its role in the corporate long-term profitability, more and more significance is put on preventive maintenance. The production and its operational aspects such as quality, costs, capacity, safety and environment are influenced by maintenance of the equipment. But, due to the fact that maintenance is considered to be a support process for production it is difficult to mark its impacts.

As stated by Swanson (2001), a successful preventive maintenance programs has the following benefits:

- ✓ By implementing a preventive maintenance program machines will work at full efficiency creating profitable uptime, while reducing downtime.
- ✓ Reduces the chances of complete machine breakdowns. Problems are recognized earlier with a preventive maintenance plan.
- ✓ Reduces the chance of emergency repair calls. If a machine goes down it can sometimes take a few days for a repair crew to get in there. Preventive maintenance can help lower the chance of something like this happening.
- ✓ Reduces downtime to locate and replace missing parts. If a part needs to be replaced it may take a few days to receive. Parts can be ordered before an unexpected failure happens.
- ✓ Saves money on energy. When machines run at their highest efficiency they will use the least amount of energy, which means saving money.
- ✓ Preventive maintenance will reduce the possibility of unnecessary repairs.
- ✓ Reduces scrap caused by poorly operating machinery.
- ✓ Reduce insurance rates since well-maintained machines are much safer.
- ✓ Reduces late deliveries that may occur due to downed machinery.

2.5 Types of Maintenances

As stated by Moubray (1997), the need for maintenance is predicated on actual or impending failure – ideally, maintenance is performed to keep equipment and systems running efficiently for at least design life of the component(s). As such, the practical operation of a component is time-based function. If one were to graph the failure rate a component population versus time, it is likely the graph would take the "bathtub" shape shown in Figure 2.1. In the figure the Y axis represents the failure rate and the X axis is time. From its shape, the curve can be divided into three distinct: infant mortality, useful life, and wear-out periods.

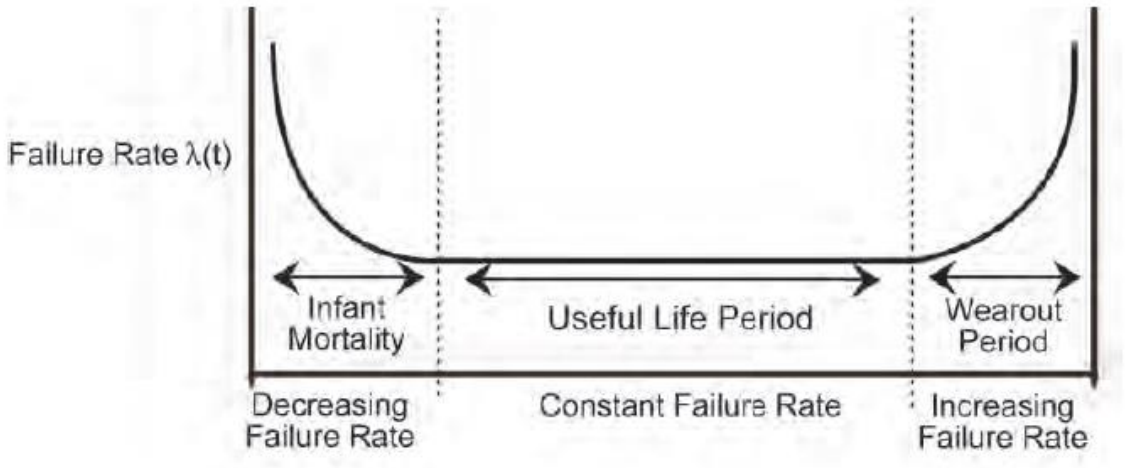

Figure 2.1 Component failure rate over time for component population
Source: Moubray (1997)

The initial infant mortality period of bathtub curve is characterized by high failure rate followed by a period of decreasing failure. Many of the failures associated with this region are linked to poor design, poor installation, or misapplication. The infant mortality period is followed by a nearly constant failure rate period known as useful life. There are many theories on why components fail in this region, most acknowledge that poor operation and maintenance often plays significant role. It is also generally agreed that exceptional maintenance practices encompassing preventive and predictive elements can extend this period. The wear-out period is characterized by a rapid increasing failure rate with time. In most cases this period encompasses the normal distribution of design life failures (Moubray, 1997).

Moubray (1997) also pointed out that the design life of most equipment requires preventive maintenance. Belts need adjustment, alignment needs to be maintained, and proper lubrication on rotating equipment is required, and so on. In some cases, certain components need replacement, (e.g., a wheel bearing on a motor vehicle) to ensure the main piece of equipment (in this case a car) last for its design life. Anytime we fail to perform maintenance activities intended by the equipment's designer, we shorten the operating life of the equipment. But what options do we have? Over the last 30 years, different approaches to how maintenance can be performed to ensure equipment reaches or exceeds its design life have been developed. In addition to waiting

for a piece of equipment to fail (reactive maintenance), we can utilize preventive maintenance, predictive maintenance, or reliability centered maintenance.

2.5.1 Reactive Maintenance

Reactive maintenance is basically the "run it till it breaks" maintenance mode. No actions or efforts are taken to maintain the equipment as the designer originally intended to ensure design life is reached. Advantages to reactive maintenance can be viewed as a double-edged sword. If we are dealing with new equipment, we can expect minimal incidents of failure. If our maintenance program is purely reactive, we will not expend manpower dollars or incur capital cost until something breaks. Since we do not see any associated maintenance cost, we could view this period as saving money. The downside is reality. In reality, during the time we believe we are saving maintenance and capital cost, we are really spending more dollars than we would have under a different maintenance approach. We are spending more dollars associated with capital cost because, while waiting for the equipment to break, we are shortening the life of the equipment resulting in more frequent replacement. We may incur cost upon failure of the primary device associated with its failure causing the failure of a secondary device. This is an increased cost we would not have experienced if our maintenance program was more proactive. Our labor cost associated with repair will probably be higher than normal because the failure will most likely require more extensive repairs than would have been required if the piece of equipment had not been run to failure. Chances are the piece of equipment will fail during off hours or close to the end of the normal workday. If it is a critical piece of equipment that needs to be back on-line quickly, we will have to pay maintenance overtime cost. Since we expect to run equipment to failure, we will require a large material inventory of repair parts. This is a cost we could minimize under a different maintenance strategy (Moubray, 1997).

Campbell and Jardine (2001) present a rule of thumb where corrective maintenance in general cost 50 % more than planned stops and breakdowns cost 200 % more than planned stops. The cost aspect is a driving factor for producing companies to shift from corrective to preventive maintenance.

2.5.2 Preventive Maintenance

According to Moubray (1997), preventive maintenance is actions performed on a time or machine-run-based schedule that detect, preclude, or mitigate degradation of a component or system with the aim of sustaining or extending its useful life through controlling degradation to an acceptable level.

The U.S. Navy pioneered preventive maintenance as a means to increase the reliability of their vessels. By simply expending the necessary resources to conduct maintenance activities intended by the equipment designer, equipment life is extended and its reliability is increased. In addition to an increase in reliability, dollars are saved over that of a program just using reactive maintenance. Studies indicate that this savings can amount to as much as 12% to 18% on the average. Depending on the facilities current maintenance practices, present equipment reliability, and facility downtime, there is little doubt that many facilities purely reliant on reactive maintenance could save much more than 18% by instituting a proper preventive maintenance program (ibid).

Additionally Moubray (1997) mentioned that Preventive maintenance has several advantages over that of a purely reactive program. By performing the preventive maintenance as the equipment designer envisioned, we will extend the life of the equipment closer to design. This translates into dollar savings. Preventive maintenance will generally run the equipment more efficiently resulting in dollar savings. While we will not prevent equipment catastrophic failures, we will decrease the number of failures. Minimizing failures translate into maintenance and capital cost savings.

2.5.3 Predictive Maintenance

As stated by Moubray (1997), predictive maintenance is measurements that detect the onset of system degradation (lower functional state), thereby allowing causal stressors to be eliminated or controlled prior to any significant deterioration in the component physical state. Results indicate current and future functional capability.

Basically, predictive maintenance differs from preventive maintenance by basing maintenance need on the actual condition of the machine rather than on some preset schedule. You will recall that preventive maintenance is time-based. Activities such as changing lubricant are based on time, like calendar time or equipment run time. For example, most people change the oil in their vehicles every 3,000 to 5,000 miles traveled. This is effectively basing the oil change needs on equipment run time. No concern is given to the actual condition and performance capability of the oil. It is changed because it is time. This methodology would be analogous to a preventive maintenance task. If, on the other hand, the operator of the car discounted the vehicle run time and had the oil analyzed at some periodicity to determine its actual condition and lubrication properties, he/she may be able to extend the oil change until the vehicle had traveled 10,000 miles. This is the fundamental difference between predictive maintenance and preventive maintenance, whereby predictive maintenance is used to define needed maintenance task based on quantified material/equipment condition (Moubray, 1997).

Moubray (1997) also argued that the advantages of predictive maintenance are many. A well-orchestrated predictive maintenance program will all but eliminate catastrophic equipment failures. We will be able to schedule maintenance activities to minimize or delete overtime cost. We will be able to minimize inventory and order parts, as required, well ahead of time to support the downstream maintenance needs. We can optimize the operation of the equipment, saving energy cost and increasing plant reliability. Past studies have estimated that a properly functioning predictive maintenance program can provide a savings of 8% to 12% over a program utilizing preventive maintenance alone. Depending on a facility's reliance on reactive maintenance and material condition, it could easily recognize savings opportunities exceeding 30% to 40%. In fact, independent surveys indicate the following industrial average savings resultant from initiation of a functional predictive maintenance program:

- ✓ Return on investment: 10 times
- ✓ Reduction in maintenance costs: 25% to 30%
- ✓ Elimination of breakdowns: 70% to 75%
- ✓ Reduction in downtime: 35% to 45%
- ✓ Increase in production: 20% to 25%.

On the down side, initially to start the predictive maintenance world is not inexpensive. Much of the equipment requires cost in excess of $50,000. Training of in-plant personnel to effectively utilize predictive maintenance technologies will require considerable funding. Program development will require an understanding of predictive maintenance and a firm commitment to make the program work by all facility organizations and management.

2.5.4 Reliability Centered Maintenance

As stated by Moubray (1997), reliability centered maintenance (RCM) is a process used to determine the maintenance requirements of any physical asset in its operating context.

Basically, RCM methodology deals with some key issues not dealt with by other maintenance programs. It recognizes that all equipment in a facility is not of equal importance to either the process or facility safety. It recognizes that equipment design and operation differs and that different equipment will have a higher probability to undergo failures from different degradation mechanisms than others. It also approaches the structuring of a maintenance program recognizing that a facility does not have unlimited financial and personnel resources and that the use of both need to be prioritized and optimized. In a nutshell, RCM is a systematic approach to evaluate a facility's equipment and resources to best mate the two and result in a high degree of facility reliability and cost-effectiveness. RCM is highly reliant on predictive maintenance but also recognizes that maintenance activities on equipment that is inexpensive and unimportant to facility reliability may best be left to a reactive maintenance approach. The following maintenance program breakdowns of continually top-performing facilities would echo the RCM approach to utilize all available maintenance approaches with the predominant methodology being predictive.

- <10% Reactive
- 25% to 35% Preventive
- 45% to 55% Predictive.

Because RCM is so heavily weighted in utilization of predictive maintenance technologies, its program advantages and disadvantages mirror those of predictive maintenance. In addition to

these advantages, RCM will allow a facility to more closely match resources to need while improving reliability and decreasing cost (Moubray, 1997).

2.6 Characteristics of preventive maintenance

According to Marquez et al. (2009), maintenance management process is divided into definition of maintenance strategy and implementation of the strategy. Definition of maintenance strategy is the selection of maintenance strategy based on the organization's objectives, maintenance policy, maintenance resources and others; while implementation of maintenance strategy focuses on the ability of management team to deal with the maintenance issues such as the ability to ensure proper skill levels, organized work preparation, appropriate equipment, schedule fulfillment and so on to perform the maintenance activities. The efficiency of maintenance implementation can be reflected by minimal waste, expense, downtime, failure or complaint.
Since preventive maintenance is more effective compared to corrective maintenance, the preventive maintenance should be introduced and implemented.

According to Mann et al. (1995), preventive maintenance involves maintenance tasks such as inspection, monitoring, cleaning, lubrication, adjustment, alignment, repair, replacement and maintenance of facilities and systems components before failures or system breakdowns occur. Meanwhile, preventive maintenance is based on component reliability characteristics and aimed to reduce the probability of component failure, as well as to minimize the system downtime (Horner et al., 1997). The researchers further explained that the cost of preventive maintenance is definitely less than the cost of failure or corrective maintenance. This is because corrective maintenance arises immediately with unexpected and extensive need of maintenance resources (Batun, 2009).

Rao (1992) described that preventive maintenance is an effective approach to enhance the reliability and quality of a system and its components. In order to prevent failure from occurring, preventive maintenance practiced should be able to indicate when a maintenance work needs to be performed.

Eti et al. (2006) supported that maximizing components reliability and extending the components life are the main purpose of preventive maintenance. It also provides a critical service function that minimizes interruptions to core business of an organization. They also pointed out that system failure causes negative impacts to the organizations, users and customers. The negative impacts could be on the aspects of output, safety, environmental integrity, system quality, customer satisfaction, and additional repair cost incurred. Thus, the implementation of preventive maintenance is necessary to replace the need of corrective maintenance. Consequently, unnecessary cost such as emergency repair cost after occurrence of failure occurs can be reduced or avoided. The required capital investment on maintenance can be minimized as well.

However, Moghaddam and Usher (2010), argued that preventive maintenance involve a basic trade-off between the contradict aims, which are to minimize total maintenance costs and to maximize the overall reliability of the facility and systems. For example, systems or components that are maintained or replaced frequently will require high maintenance cost, but they will provide high reliability. Therefore, a balance between the two aims must be reviewed and obtained in order to achieve the effectiveness of preventive maintenance.

Preventive maintenance is maintenance carried out in accordance with predetermined interval of time, number of operations, mileage and others to ensure that such components are performing in good condition. The maintenance strategy is a planned maintenance approach. Whereby, the implementation of maintenance activities is based on the planned program or schedule that has been determined by the maintenance personnel in the planning stage. Hence, the facility systems or services are able to perform their functions as required by the owners and occupants (Horner et al., 1997).

Preventive maintenance is aimed to avoid premature failure or defect of the systems and their components. Normally, Preventive maintenance is the tasks of checking and replacement in predetermined period of time to overcome the problem of wear and tear (Bevilacqua, 2000). Eventually, Hameed et al. (2010) supported that maintenance activities performed at fixed time interval are means to reduce the probability of failures and breakdowns. The researchers further explained that the expected downtime is low and spare logistics is easy by implementing

preventive maintenance. They also indicated that the maintenance performance of preventive maintenance relies on the criteria stated below:

(a) Skilled labor – the maintenance personnel who are able to perform the check and replacement works.
(b) Spare parts and materials – the availability of spare part or material in terms of supply and cost.
(c) Predetermined interval for maintenance – the period of time, number of operation or mileage that is fixed between each maintenance or replacement task.
(d) Cost allocation for failure or downtime – the cost incurred due to unexpected failure (includes the system breakdown that requires additional repair and downtime for rectifying work) or regular preventive maintenance downtime.

A. Skilled Labor

Since preventive maintenance is carried out in a fixed time interval, it does require permanent maintenance personnel or technicians to perform the tasks (Lai et al., 2008). The researchers also pointed out that one of the cost items that need to be considered in preventive maintenance budgeting is labor cost.

Typically, some of the preventive maintenance works are determined by experienced and skilled technicians, who observe the wear and tear of the parts or components. Thus, the technicians should not only limit their capability to replacing and overhauling system components, but they must be capable to identify the need of preventive maintenance. For example, technicians may decide to make adjustment on maintenance interval when they perform system inspection at each time of the preventive maintenance interval (Mann et al., 1995).

According to Kangwa and Olubodun (2003), one of the main barriers to effective preventive maintenance management is lack of skill and knowledge. They further explained that inability to determine quality of work done by the maintenance personnel themselves may lead to the occurrence of bad impact, such as incompetency in detecting unwanted error and mistake made by them.

Commonly, organizations allocates different amount of salary for the maintenance personnel based on their category of competency. Competency of the maintenance labor force is an important factor that affects the preventive maintenance outcome (Groote, 1995).

Horner et al. (1997) claimed that labor is highly demanded for preventive maintenance activities. Preventive maintenance requires large amount of budget allocation in terms of labor aspect.
Ali et al. (2010) suggested employing minimum but optimum labor with acceptable qualification standard as one of the measures to minimize preventive maintenance cost. Based on the statement, it is found that the number of skilled labor must be sufficient to maintain the reliability and quality of building and systems. Idrus et al. (2009) explained that preventive maintenance management is a process that allocates and coordinates the resources, including the labor to enhance the maintenance performance such as reliability, safety, function, comfort, and convenience. Thus, skilled labor is one of the main characteristics to be considered for implementation of preventive maintenance.

B. Spare Parts and Materials

Hassanain et al. (2011) defined spare parts as all parts, equipment and expandable assets to operate a system for certain period of time.

Every part or component in a system has its own life time; it needs to be replaced when it has reached the end of its lifetime. For example, preventive maintenance requires several categories of spare parts including exchange parts, lubricants, other materials for maintenance such as rags, cleaning solvents and others. Thus, it is important to have the spare part for replacement to ensure a system is operating consistently. In order to improve the maintenance performance, one of the important criteria is proper management of spare parts and materials (Swanson, 2001). Basically, management of spare parts and materials includes the study of spare part needs, efficiency of spare parts reordering, level of stocks of spare parts, and storage of spare parts (Groote, 1995).

Tsang (1995) stated that accurate spare parts identification and stocking helps to control and reduce the operation and maintenance costs. The cost for spare parts and materials required in preventive maintenance is one of the major costs in facility services preventive maintenance.

According to Horner et al. (1997), spare parts and materials are much required for preventive maintenance compared to other maintenance strategies. Some parts of facility systems or services need to be replaced with new ones in fixed interval as determined in the maintenance program schedule, whether in cases where the items are damaged or not. Thus, the availability of spare parts is highly concerned in preventive maintenance as it can affect the preventive maintenance performance.

Eti et al. (2006) indicated that a good maintenance manager should be able to allocate adequate spare parts and materials for maintenance programs at minimum cost without jeopardizing the quality of systems.

Ali et al. (2010) found that the quality of spare parts and materials always has an impact towards preventive maintenance performance. Obviously, selection of good quality spare parts and materials can reduce the maintenance budget and downtime loss. On the other hand, poor quality spare parts and materials have shorter service lifespan compared to the good ones, leading to more defects in a system. In some circumstances, poor quality items might be damaged before the predetermined replacement schedule and this would affect the whole system operation. As a result, repair works need to be carried out and additional maintenance cost is incurred. Therefore, the selection of spare parts and materials should not only concern cost saving, the quality of spare parts and materials is another essential aspect to be taken into consideration.

C. Predetermined Interval for Maintenance

In order to reduce the risk of failure, preventive maintenance works are performed at fixed intervals regardless of other information (Tsang, 1995). Nevertheless, Mann et al. (1995) observed that the preventive maintenance is based on the use of statistical and reliability analysis of system and component failure. Specified interval where the component will be worn out is

estimated. Then, the fixed preventive maintenance interval to replace or overhaul parts or components is established and optimized to achieve minimal preventive maintenance expenses. The interval of preventive maintenance activities is vital, whereby inappropriate predetermined preventive maintenance interval affects the preventive maintenance outcome (Tsang, 1995).

Preventive maintenance requires an intrusion of the system. It can only be back into operation when the maintenance task is completed. In some cases, often intrusion of the components may affect the effectiveness of the system. Unavailable or delayed action to perform preventive maintenance task at the right time may cause further damages to the system components. It is necessary to apply appropriate preventive maintenance treatments at the right time to extend service life of the components (Chen et al., 2003).

However, Yang (2004) argued that the preventive maintenance programs might not be able to avoid the risk of failure from occurring in system components before the fixed replacement time. This problem occurs due to unknown condition of the system components.

Direct maintenance cost will increase with a tight preventive maintenance or short interval; while downtime and remedial cost due to system breakdown may be expensive with a loose preventive maintenance or long interval (Chareonsuk et al., 1997).

According to Bahrami et al. (1999), if preventive maintenance activity is performed rarely, downtime due to sudden breakdown will increase. On the other hand, if preventive maintenance work is performed too frequently, downtime due to maintenance interruptions will increase. Moghaddam and Usher (2010) further explained that frequent preventive maintenance or replacement enhances the reliability of a system, but it is costly at the same time. Thus, Pandey et al. (2010) indicated that it is advisable to obtain an optimal preventive maintenance interval that minimizes the cost of preventive maintenance tasks.

As per Bahrami et al. (1999), a balance between direct preventive maintenance cost and downtime of preventive maintenance cost is necessary to be obtained, as it influences the

expenditure on facility maintenance. Meanwhile, a compromise between the downtime due to preventive maintenance interruptions and sudden breakdown is required.

In order to achieve the balance and resolve the problem of under-maintaining or over maintaining of systems, an adequate maintenance interval must be identified and performed (Eti et al., 2006).

D. Failure and preventive Maintenance Downtime

Down time is one of the causes that affect preventive maintenance performance. However, facility systems are subjected to downtime because of preventive maintenance activities, components failure, inspection, and material shortages (Batun and Azizoglu, 2009).

Groote (1995) noted that there are two types of downtimes including planned downtime and unplanned downtime. Planned downtime occurs when the regular preventive maintenance task is performed; while unplanned downtime occurs when there is sudden breakdown or failure. He also noted that, downtime involves the time required for detection, repair or replacement and restarting the system which implies unavailability of services and facilities. The occurrence of downtimes is likely to affect the activities of core business such as loss of production.

According to Batun and Azizoglu (2009), the maintenance downtime occurs due to the maintenance activities, which is divided into minor and major activities. Minor preventive maintenance activities usually need shorter durations and involve some routine operations such as cleaning, lubrication, oil changes, re-alignment, and minor adjustments; while major preventive maintenance activities take longer durations and involve system restoration like tool changeovers, replacement of components, major overhauls and inspection. Major preventive maintenance is compulsory after the system has operated for a long time frame. In order to minimize the preventive maintenance downtime, a few minor preventive maintenances are regularly performed between two consecutive major preventive maintenances.

Yang (2004), had mentioned that the preventive maintenance is not able to prevent the risk of failure, budget allocation for cost of failure and downtime should be considered when planning the preventive maintenance approach. In addition, Chandrashekaran (2008) proposed that the

preventive maintenance downtime is one of the potential risk impact parameters for maintenance management in the event of system failure.

According to Zuashkiani et al. (2011), breakdown may cause collateral damage in a particular system. For instance, insufficient or polluted engine oil of a standby generator set may damage the engine. Relatively, additional cost will be incurred for the failures occurring before the predetermined preventive maintenance time.

Chareonsuk et al. (1997) noted that most of the maintenance managers compute maintenance expenditure only in terms of direct maintenance cost. They often neglect the downtime cost that might be very costly, especially in the production industry. Inevitably, implementation of preventive maintenance and repair works requires certain downtime with possible lost production cost. Thus, the downtime for preventive maintenance must be well managed to avoid unnecessary cost. Due to the downtime, the organizations operations can be jeopardized critically.

Parida and Kumar (2006) found that preventive maintenance and failure downtime always have an impact on the system quality, as well as health, safety and the environment. Hence, the cost allocation for failure and preventive maintenance downtime must be taken into consideration for the planning and execution of preventive maintenance activities.

2.7 Factors Influencing Decision to undertake preventive Maintenance

Derek and Paul, (1987) identify the following factors as influencing the decision to do not carry out preventive maintenance:

1. *Inadequate finance*-it is generally acknowledged that inadequate finance is a major constraint on effective property management, partly because preventive maintenance budgets are the easiest to cut when money is scarce.
2. *Bad management*- refers to the idleness and waste among maintenance personnel.

3. *Poor facility design*- it is not uncommon to find that facilities are inherently expensive to maintain because of inappropriate priorities applied during the design phase. Poor detailing and the specification of unsuitable components and materials are common complaints. In addition, construction errors arising from inadequate drawings and specifications, coupled with poor workmanship because of contracts awarded to incompetent contractors are frequent causes of rapid physical deterioration in facilities. Good design should allow accessibility and adequate working space for essential maintenance such as cleaning, and minor repairs to pipes, ducts and cables.

4. *Availability of physical resources*- the availability or non-availability of physical resources affects decisions in that, when suitable materials for preventive maintenance are not available, it becomes difficult to undertake preventive maintenance. Again even if suitable materials are available but not in adequate quantities and the alternative materials are not available, it will deter people from undertaking preventive maintenance activities. The level of craftsmanship in terms of both skills and efficient numbers can also affect decisions to carry out preventive maintenance.

Seeley (1993) on the other hand, summarizes the principal criteria which could influence the decision to carry out preventive maintenance briefly as, cost, age and condition of property, availability of adequate resources, urgency, future use and sociological considerations.

2.8 Steps to implementing Effective preventive maintenance program

According to Gross (2002), the steps for effective preventive maintenance are the following:

1. Establish scheduling.

Scheduling involves planning the activities of the maintenance crew.

Planning means assigning work orders by shift, by day, by task importance, by material availability, by manpower availability, and by production downtime. In planning, the most important thing is giving priorities. The following machines should have given high priority:

- Machines with safety hazard.
- Machines vital for the operation.
- Machines those are expensive.
- Machines with no substitute.

2. Develop an equipment list and assign equipment numbers.

Creation of the master equipment list requires three actions:

I. Developing a numbering system for your plant and the equipment

II. Gathering a list of all the plant's equipment

III. Organizing the equipment into this structure

After completing the above activities, you will have the basic structure for controlling work orders, coupled with the ability to collect trend data by area and by equipment types.

Finally, once all the equipment has been assigned numbers, then label each piece of equipment with its newly assigned number.

3. Develop and issue preventive maintenance instructions.

Start the process by looking at your newly developed equipment list and creating groupings of identical equipment. Once you identify the largest groups of identical equipment, get preventive maintenance instructions developed for these groups. Create a separate work order for each preventive maintenance interval (e.g., weekly, monthly, semiannually, etc.).

A good preventive maintenance work order lists:

- ✓ All the required safety steps
- ✓ All the definitive sequential steps
- ✓ All the required readings and settings
- ✓ All the required tools
- ✓ All the required replacement parts (by part number, size, or some other applicable description)
- ✓

4. Locate and/or develop equipment manuals.

With real manuals in your shop, when an uncommon or complex problem arises, then you will have the necessary information on hand to quickly troubleshoot it.

A real manual contains:

- ✓ Operating procedures
- ✓ Troubleshooting guide
- ✓ Schematics
- ✓ Parts lists
- ✓ Other significant items (e.g., manuals for specific process control equipment)

It is equally important to keep the contents of the manuals updated. An easy way to keep them current is by issuing a semiannual inspection.

5. Develop a managed inventory.

The best maintenance system only works as well as the parts inventory and supply system that supports it.

You will walk a fine line with your parts inventory— having enough, having too much, or having nothing at all. As you set up your inventory, you should keep these thoughts in the back of your mind:

- ✓ Costs (i.e., what is the inventory holding cost versus purchasing the parts as needed?)
- ✓ Uptime requirements (i.e., can you afford to be down while you get the needed parts?)
- ✓ Parts accessibility (i.e., are you located in a large city with vendors down the street, or are you located in a small town six hours from a major airport?)
- ✓

The inventory management process begins by having a clear understanding of why you have parts stored on-site: to quickly fix equipment. Always remember that equipment downtime and parts inventories both cost the company money. Your job is to determine which is cheaper.

Regardless of the trade-offs, here are the basics of inventory management:

- ✓ You require spare parts to repair your equipment.
- ✓ You determine what you need to stock in-house to maintain acceptable uptime.

- ✓ You use these spare parts, and then you buy more.
- ✓ You keep enough stock in the inventory to always have the necessary repair parts.

6. Monitor the program's effectiveness and make improvements.

Consider scheduling periodic quality audits of preventive maintenance work orders. This quality audit ensures that procedures are being followed and that the technicians understand the preventive maintenance process.

Additionally, as you make changes to your equipment, make changes to the preventive maintenance instructions. Also, as repair parts or lubrication products change, make sure to update the preventive maintenance work orders accordingly.

2.9 Type of Maintenance in hotel

Chan et al. (2003), classified maintenance activities in hotels into four main categories:
Routine, corrective, preventive, and emergency.

Routine maintenance refers to the daily activities with repetitive nature, such as taking meter readings, lubricating, monitoring, start-up, and shut-down.

Corrective maintenance works are scheduled or unscheduled activities to restore the equipment to as-built functions.

Preventive maintenance includes scheduled activities of inspection, adjustment, replacement and overhaul to prevent system breakdown and extend its useful life.

Emergency maintenance refers to immediate actions to avoid further equipment damage and adverse consequences, such as loss of business.

They indicated that there was as much as 30 percent of the maintenance resources are spent on routine maintenance. However, the maintenance personnel often took an attitude of overlooking routine maintenance as something insignificant because they are not aware that routine maintenance and preventive maintenance, if properly carried out, would effectively reduce system breakdown. If there is no clear maintenance policy, resources spent on routine

maintenance may be wasted. System operating parameters should be monitored and compared against the criteria, and follow-up actions have to be taken for non-compliance or equipment failures (Chan et al., 2003).

The relative portions of the above four types of maintenance activities studied in the hotels are shown below.

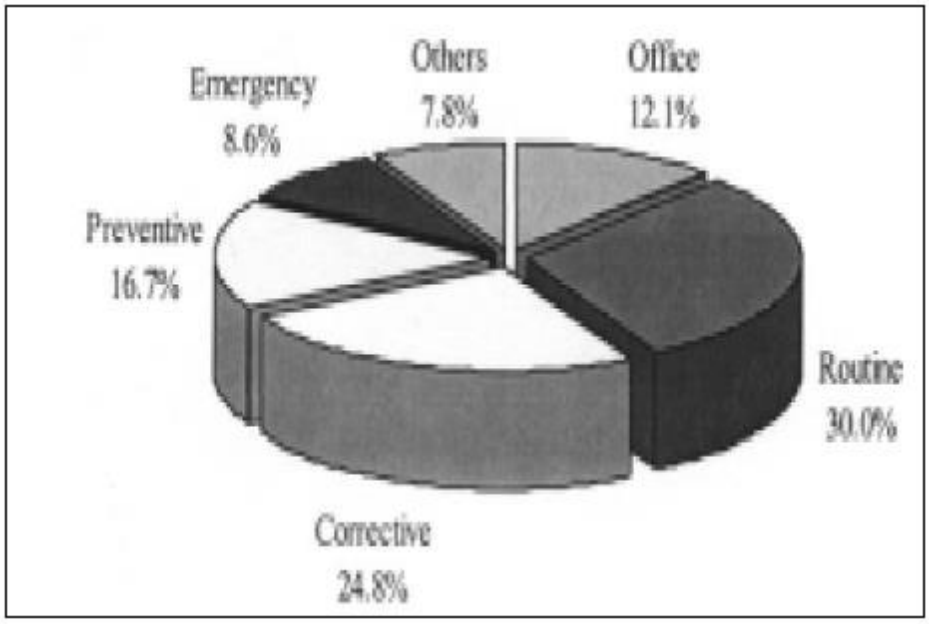

Figure 2.2 Percentage breakdown of Maintenance

Source: Chan et al (2003)

Included in the figure are proportions for office works and others, which in the opinion of the writers represent the proportion of man hours used for supervisory works, inventory control and non-maintenance works which assist the actual execution of maintenance. Preventive maintenance for hotels requires a much higher reliability. In the hotels studied one measurement of the maintenance effectiveness is the ratio of preventive maintenance to corrective maintenance actions in terms of man-hours use, called the preventive maintenance ratio. The observation is that the maintenance workforce is tied up with corrective work, which is commonly observed in

hotels however in the writers' opinion for long-term improvement; management must turn their attention from corrective maintenance to preventive maintenance (Chan et al., 2003).

In addition to this observation, preventive maintenance according to Lind and Muyingo (2011), is rational if the consequences of a fault are high in relation to the cost of doing something that in advance reduces the risk for a fault. It also provides the advantage of being able to carry out actions when it is convenient to the user. The decision to carry out preventive maintenance can be based either on the age, the time between activities or on the monitored conditions of the item and depending on the specific situation. Moreover the writers explained that despite the fact that it reduces probability of equipment failures and extends equipment life it involves a number of unnecessary tasks carried out on items that could have remained in a safe and acceptable operating condition for a much longer time.

2.10 Strategies in hotel maintenance

Chan et al (2001) observed that in the development of maintenance strategies and programs, health and safety have become fundamental requirements for business success because they depend on good preventive maintenance practices to avoid hazards in the facilities or workplaces. A preventive maintenance strategy sets the direction of maintenance management, whereas the preventive maintenance program is a comprehensive schedule of maintenance works carried out in a specified period of time. Both however involve a high level of decision making because customer perception of quality is determined by a number of factors relating to services, food, facilities and indoor environment. As regards to energy consumption, the writers result reflected that management is willing to make every effort to improve preventive maintenance management for energy savings. As such a sound preventive maintenance strategy should be developed and implemented to keep the engineering systems reliable, safe, and energy efficient, satisfying customer needs and expectations.

Chan et al (2001) also pointed out that in preventive maintenance practice several factors are considered before adoption of in-house technicians, out-source contractors, or combination of both. There is no general rule for a desirable ratio of in-house to contracted-out labor force on which management decision is based but the availability of resources and a number of other factors are considered. They also observed that limited skills of in-house technicians in

specialized disciplines were weighed by the chief engineers as the most significant factor driving the management to employ outsourcing labor for some maintenance and retrofitting works. Time constraints was considered as a factor since the main income of the hotels are from the rent of guest rooms and the provision of food and beverage services, including restaurants and banquet halls, therefore longer downtime of critical equipment and functional areas will lead to a serious loss of business. As a result, the management has to carefully compare the working time needed by the outsourcing contractors with the in-house staffs.

In general, specialized contractors are better equipped and have flexible manpower that will ensure that tasks are completed on time. Statutory requirements were also weighted high because it is stipulated in local regulations that some activities, such as maintenance of fire protection systems, lifts and escalators, must be carried out by authorized contractors (Chan et al., 2001).

Espino-Rodr´ıguez and Padr´on-Robaina (2005) also mentioned that the hotel industry is characterized by much outsourcing; however there is too much focus on economic activity and some aspects of organizational behavior which are crucial for decision making are ignored. In their opinion if a resource has strategic value to a hotel activity and has some potential that makes it rare, valuable, imperfect, imitable and non-sustainable then it should not be outsourced because that resource must not be directly transferable in the market; this will make it easier for the firm to make profit, as it gains competitive advantage over other resources. Moreover the writers stated that the fewer the resources and capabilities employed by the hotel, the likelihood of having them obtained from outside the hotel. If a hotel possess advantage when it comes to in-house performance it is unlikely to outsource.

Finally, the writers mentioned that when a service can be provided more efficiently by third parties, it should be outsourced and activities that that do not contribute to development of core competences and of little strategic value should be outsourced (ibid).

2.11 Preventive maintenance at Sheraton Addis

Sheraton maintenance management system manual (SMMSM) (2013) described that Hotel preventive maintenance is like a puzzle. The complexity of that puzzle depends on the environment in each property, the local market, and the economy. Often, preventive maintenance is postponed or skipped due to limited resources, but this only delays problems which are likely to become much more severe. But preventive maintenance isn't just fixing things, how well the maintenance department maintain a property will have an impact on guest loyalty. All hotels have beds, televisions and marble-top sinks. What set the maintenance department apart are the service and the quality of the property. The effort put forth in preserving the asset and equipment will reflect in the guest satisfaction scores and the bottom line.

Hotel preventive maintenance is no easy task as it requires coordination between departments and flexibility around occupancy. Limited staffing can make it difficult to complete scheduled maintenance since so much effort is placed on putting out fires. The problems are the same everywhere. Fortunately, Computer maintenance management system (CMMS) offers an excellent feature set that delivers the tools necessary for staff members to easily capture and process work while creating the visibility and accountability necessary for proper work force management (ibid).

According to the manual, in Hotel industry, occupancy is a constant challenge when it comes to preventive maintenance. With CMMS properties can see which rooms are unsold and plan daily preventive maintenance accordingly. This helps prevent excessive backlog. The preventive maintenance calendar shows future preventive maintenance tasks including parts and hours required to assist in planning.

The manual also mentioned that while preventive maintenance is essential, issues occur on a regular basis that require tracking and follow up. CMMS support unplanned maintenance actions including guest-focused response tools. Open work requests can be organized into custom lists per user. This is to help the user focus on what is important. Real-time information keeps everyone informed of the up-to-the-minute status of any issue. Audit trails and logs ensure accountability as every transaction is tracked.

The Pooling engine in CMMS automates the distribution of work ensuring the work reaches the right person. Factors like time of day, day of week, type of work and even location determine how the work should be sent out. The Pooling engine will even load balance the distribution of work between members of a pool to ensure no one person is over-loaded. The feature set and multiple interfaces are designed to reach individuals where they are comfortable and effective. Entering data is extremely fast and easy (Sheraton maintenance management system manual, 2013).

The manual in summary states, a comprehensive maintenance program will save the hotel money and improve the quality of the guest's experience. It will also result in an increase in staff efficiency and accountability. "Remember, you don't have to manage maintenance, but if you don't, it will manage you."

2.12 Review of Empirical Evidence

Considerable research has been carried out on: the impact of preventive maintenance on manufacturing performance (McKone*et. al*., 2001); the effect of optimized maintenance system in vehicle industry (Aghae and Fazli, 2012); the application of preventive maintenance on parquet enterprises; and the implementation of preventive maintenance at a palm oil mill among others.

In today's highly and rapidly changing environment, the global competition among organizations has led to higher demands on organizations. The global marketplace has witnessed an increased pressure from customers and competitors in the manufacturing as well as service sectors (Basu, 2001; George, 2002). This calls for effective improvements in the company's performance by focusing on cost cutting, increasing productivity levels, quality and generating deliveries in order to satisfy customers.

However, steady improvements do not guarantee sustained profitability or survival of an organization (Oke, 2005). Attention has, therefore, been shifted from increasing efficiency by means of economies of scale and internal specialization to meeting market conditions in terms of

flexibility, delivery performance and quality. These changes have left unmistakable marks on the different facets of organizations (Gomes *et. al.*, 2006).

Maintenance is normally perceived to have a poorer rate of return than any other major budget item. Yet, most companies can reduce maintenance costs by at least one-third, and improve the level of productivity by giving preventive maintenance the management priority it requires (Ahuja and Khamba, 2007). That priority must span all levels of an organization's management structure to develop an understanding of the significant effect preventive maintenance can have upon the success or failure of organization objectives. The maintenance processes can be streamlined to eliminate waste and produce breakthrough performance in areas valued by customers. In financial terms, maintenance can represent 20 to 40 per cent of the value added to a product as it moves through the plant. Therefore, equipment preventive maintenance is an indispensable function in a manufacturing enterprise (Ahmed *et. al.*, 2005).

The effective integration of maintenance function with other functions in the organization can help to save huge amounts of time, money and other useful resources in dealing with reliability, availability, maintainability and performance issues (Moubray, 2003).

In the hospitality industry, the concept of product is taken deceptively simple, at first glance. A tourism product presumably is whatever one buys while away from home. From a marketing perspective, one can define a product as "anything that can be offered to a market for attention, acquisition, use or consumption that might satisfy a need or want. It includes physical objects, services, person, places, organization, and ideas. Marketers, however, tend to view tourism products and services - in general - as being fairly complex phenomena.

The quality of hospitality services is one of the most important parameters in the hotel industry. The key factors of determining the level of quality are: the level of performance and condition of the object; quality and modernity of equipment; selection, professional preparation and conduct of staff; external condition (culture and wealthy society, the level of economic development, the existence of competition); reliability of implementation; speed of service; confidence and professionalism of service; and individual approach to clients.

Computerized maintenance management systems (CMMS) assist in managing a wide range of information on maintenance workforce, spare-parts inventories, repair schedules and equipment history. It may be used to plan and schedule work orders, to expedite dispatch of breakdown calls and to manage the overall maintenance workload. CMMS can also be used to automate the preventive maintenance function, and to assist in the control of maintenance inventories and the purchase of materials. CMMS has the potential to strengthen reporting and analysis. The capability of CMMS to manage maintenance information contributes to improved communication and decision-making capabilities within the maintenance function.

Accessibility of information and communication links on CMMS provide improved communication of repair needs and work priorities, improved coordination through closer working relationships between maintenance and production, and increased maintenance responsiveness. Hotel ServicePro is a hotels' inspection software and it provides a platform for conducting consistent inspection. It allows the scheduling of inspection, provides reports and helps management identifies training opportunities for maintenance team members, and it improves quality assurance inspection scores.

Smith (2011) stated that just like meeting a person for the first time, it takes hotel travelers less than 60 seconds to form an initial impression of a hotel or resort. Travelers may first take notice of the parking, signage, décor, carpet, or even the smell. Although each visitor is keyed to something different, each first impression is influenced by aspects of asset management and maintenance.

Kauppi and Paavo (2005) described maintenance processes and procedures as being of preventive maintenance type when: there is prevention of equipment breakdown before it happens and this includes inspection, adjustments, regular service and planned shutdowns; repair work, that is, repairing equipment and troubleshooting malfunctions in an effort to return the equipment to its previous condition, and these repairs may be reactive or prevention; and improvement of work, for instance, searching for better materials and improved design changes to facilitate equipment reliability, while repair is often a part of improvement.

In pursuit of acquiring an edge over its competitors, and using preventive maintenance processes as a strategy for its business, an organization could develop a business-level strategy. A business-

level strategy is a comprehensive mechanism employed to gain competitive advantage or superiority in a particular business or industry. It specifies the advantage the firm seeks in that business, relative to competition and how available resources will be applied to acquire it – this is the means a firm employs to give strength which provides a foundation on which to organize its business decisions and (Parthasarthy, 2007). Selecting preventive maintenance as a business-level strategy is an attempt to answering the question how will the firm compete in its business or industry?

A firm's analysis of its internal environment based on information generated from its own competencies and that of the industry in general, aids in selecting an appropriate strategy for its business, while the industry analysis identifies the competitive pressures in the industry and helps in determining whether to pursue the opportunities in the overall industry or within specific market segments. Evaluating industry condition side by side with internal strengths enables a firm to select an appropriate business-level strategy that integrates industry opportunities with the firm's competencies (ibid).

2.13 Summary of literature

Standards of operations are improved through the resultant formulation of corporate strategy and a competitive edge in the marketplace. Business unit strategies adopted in the production and service levels in the context of preventive maintenance, ensures guests' needs and expectations are met at all times. This achievement brings to for a new front in corporate branding in the hotels industry that has never been appreciated before. This gap in the hotel industry when fulfilled through the adoption of a preventive maintenance program would realize zero tolerance on reduced cost of operations, job security, developed skills and personnel acceptance, minimum mean time between failures, and improved market position.

CHAPTER THREE

RESEARCH METHDOLOGY

This chapter describes the methods and procedures that are used in carrying out this research. It deals with the research design, population and sampling technique, type of data collected, Method of Data Collection and method of data analysis

3.1. Research Design

The study adopted a descriptive research design. According to Mugenda & Mugenda (2003), descriptive research is used to obtain information concerning the current status of the phenomena to describe what exists, with respect to variables or conditions in a situation. Descriptive research design was used in this study since the researcher intended to look at the problem at hand thoroughly to define it, clarify it, and obtain pertinent information that could be of use in assessment preventive maintenance at Sheraton Addis. Furthermore, the method helps to engage quantitative and qualitative statistics to organize information in meaningful ways.

3.2 Target Population and Sampling Technique

The organization has total population of around 750 employees in 11 departments. From 11 departments, the researcher took four departments namely; engineering, housekeeping, food preparation and stewarding using Purposive sampling technique. The total population of these selected four departments is 275.

The researcher chooses these departments using purposive sampling, because these departments are closely related to the subject matter of the study.

The study used the following sample size determination formula to determine the sample size of the population. It is determining by using the formula that was developed by Taro Yamane (1967). It is calculated as follows:

$$n = \frac{N}{1+N(e)^2}$$

Where **n** is the sample size,

N is the population size, and

eis the level of precision or sampling error = (0.05)

The total populations of the selected departments are 275.

$$n = \frac{275}{1+275(0.05)^2} = 163$$

Hence, the total sample size of 163 was chosen from the selected departments using convenience sampling for the study.

3. 3 Type of Data collected

Primary data was collected from primary sources through holding interview with the chief engineer and questionnaires were distributed for sample employees. Secondary data was collected from Sheraton maintenance manual.

3.4 Method of Data Collection

The researcher used questionnaire and interview to collect the necessary data. Interview was held with the chief engineer; and a questionnaire was distributed to employees of the sample population.

3.5 Method of Data Analysis

In order to arrive of a certain conclusions, data collected through interview and questionnaire was edited, classified, tabulated and analyzed using qualitative and quantitative methods. And different percentage, ratio, average methods and Standard deviation were used with the help of tables.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1. General characteristics of the Respondents

To get necessary data about preventive maintenance practices of Sheraton Addis Hotel, questionnaires were designed and distributed to 163 engineering management, engineering non-management and preventive maintenance program user employees of the hotel. Out of total questionnaires distributed 131 (80.4%) questionnaires were filled and returned. Interview was also designed and conducted with the chief engineer of the hotel.

The first part of the questionnaire consists of the demographic information of the participants. This part of the questionnaire requested a limited amount of information related to personaland professional demographic characteristics of respondents. Accordingly, the followingvariables about the respondents were summarized and described in the subsequent graphs and tables. These variables includes: Gender, age, department, educational level, work experience and position.

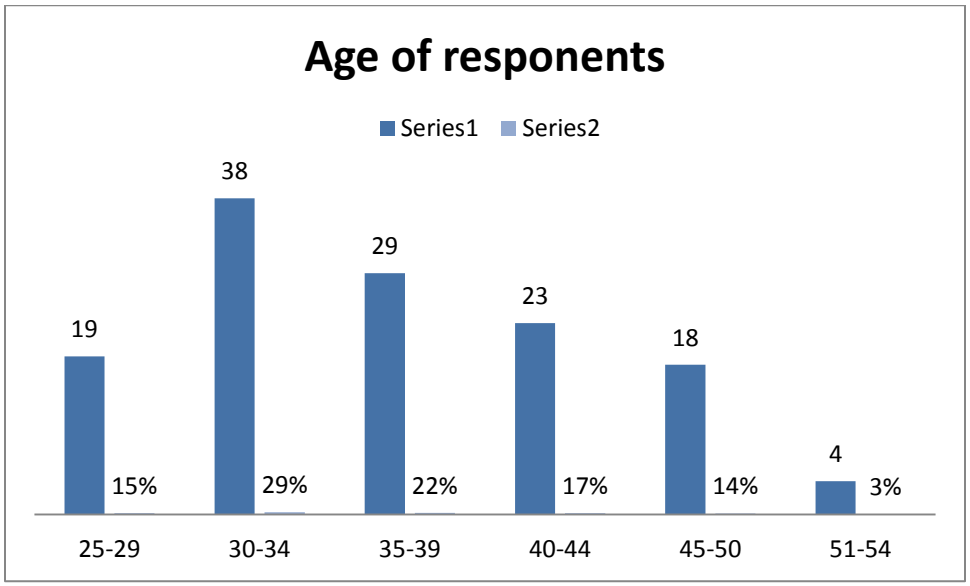

Figure 4.1:Summary of number and percentage of respondents by age

Source: (Own survey, December 2017)

In terms of age distribution 97% of respondents were in the age between 25-50 years. This indicates that, most of the respondents are in active, creative and productive age.

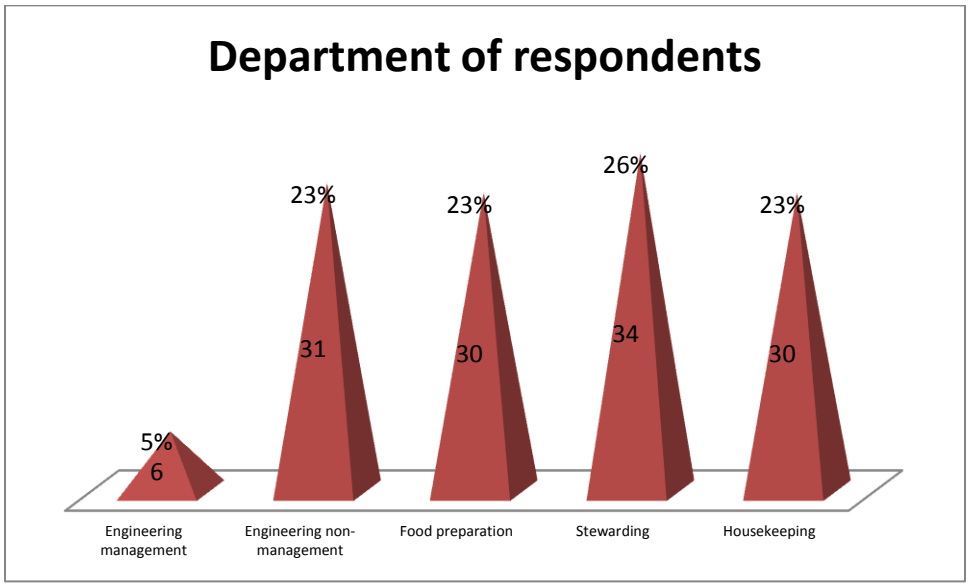

Figure 4.2:Summary of number and percentage of respondents by department

Source: (Own survey, December 2017)

As indicated in figure 4.3 above, 5% and 23% respondents were from enginering management and engineering non-management respctively. The rest 72% are from user department (equal 23% from food preparation and housekeeping and 26% from stewarding).

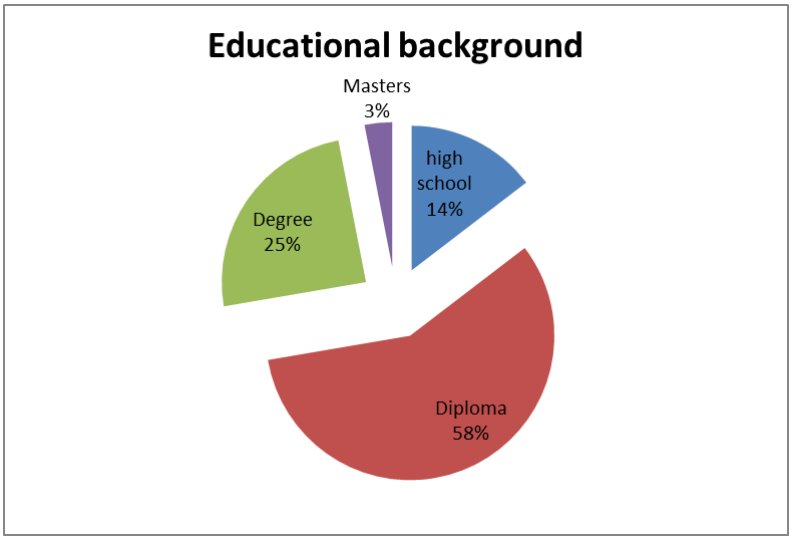

Figure 4.3: Summary of percentage of respondents by educational background

Source: (Own survey, December 2017)

The respondent educational qualification were composed of 58% diploma holders, 25% degree holders, 3% master degree holders and the rest 14% have completed high school. This helps the respondents understand and answer the questioner so the study will be truthful and accurate with reliable and trustworthy data.

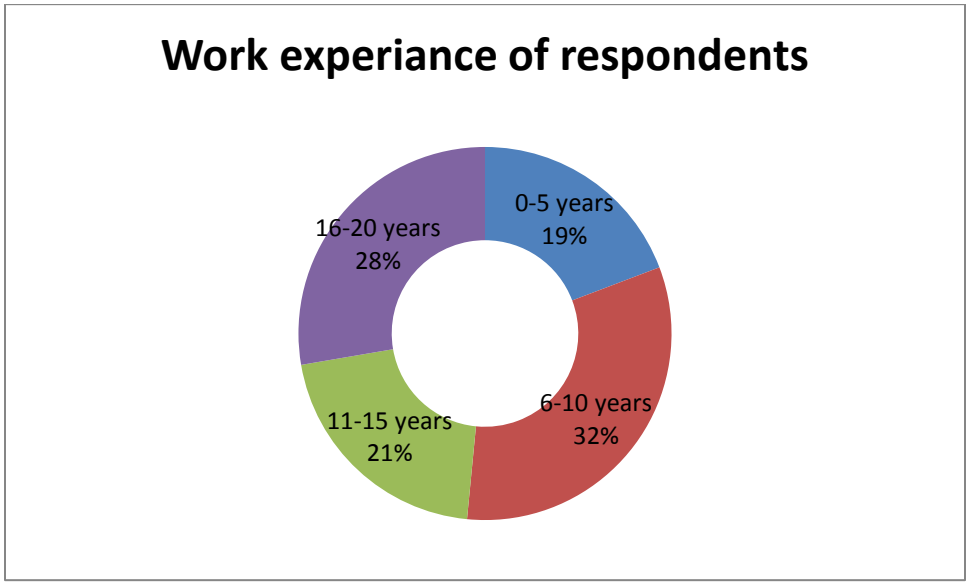

Figure 4.4: Summary of percentage of respondents by work experience at Sheraton Addis

Source: (Own survey, December 2017)

As it can be seen in the above table, 81% of respondents have more than 5 years' work experience at Sheraton Addis hotel. This is another opportunity to get accurate and reliable data.

4.2 ANALYSIS OF THE MAJOR FINDINGS

Table 4.2.1: Summary of availability of manpower

	Question	measurement	Engineering management		Engineering non-management		User department	
			freq	%	freq	%	freq	%
1	The engineering department is well staffed in terms of education and experience.	Strongly agree	1	16.7	4	12.5	10	10.8
		Agree	4	66.7	8	25	27	29
		Neutral	1	16.7	13	40.6	32	34.4
		Disagree	0	0	6	18.7	19	20.4
		Strongly disagree	0	0	1	3.1	5	5.3
		Total	6	100	32	100	93	100
		Mean	**4**		**3.25**		**3.194**	
		SD	**0.632**		**1.016**		**1.056**	
2	The engineering department skilled labor is satisfactory in terms of quantity (number) to accomplish preventive maintenance program.	Strongly agree	1	16.7	2	6.25	9	9.7
		Agree	3	50	4	12.5	21	22.6
		Neutral	1	16.7	16	50	31	33.3
		Disagree	1	16.7	6	18.75	22	23.7
		Strongly disagree	0	0	4	12.5	10	10.8
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.81**		**2.97**	
		SD	**1.033**		**1.03**		**1.137**	
3	The engineering teams are assigned to do preventive maintenance on their specialized knowledge.	Strongly agree	2	33.3	3	9.4	11	11.8
		Agree	4	66.7	8	25.0	30	32.3
		Neutral	0	0	13	40.6	31	33.3
		Disagree	0	0	7	21.9	17	18.3
		Strongly disagree	0	0	1	3.1	4	4.3
		Total	6	100	32	100	93	100
		Mean	**4.33**		**3.16**		**3.29**	
		SD	**0.516**		**0.987**		**1.038**	

Source: (Own data, December 2017)

The above table summarizes employees' knowledge towards availability of human resources the work place. The extent to which employees agree or not to the statement "The engineering department is well staffed in terms of education and experience", majority (66.7%) and (16.7%) engineering management respondents claim it to be "agree" and "strongly agree" respectively.
In this response in the interview the chief engineer also agrees that the quantity of the manpower is enough in terms of quality and quality. He added that, all technicians have a minimum of diploma in technical education.

From engineering non-management respondents only 12.5% and 25% "strongly agree" and "agree" respectively. Majority of engineering non- management respondents (40.6%) and 18.7% reply "Neutral" and "disagree" respectively.
The user department's response was similar to engineering non- management respondents; which is "strongly agree "only 10.8% agree 29%, neutral 34.4% and disagree 20.4%.
While total (83.4%) engineering management respondents agree and 16.7% "neutral" with the statement, no one from the engineering management "disagree" with the statement".

On the other side, less than half engineering non-management 37.5% and 39.8% user department respondents agree with the statement and 40.6% from engineering and 34.4 user department are "neutral". Additionally, 18.7% and 20.4 engineering non- management and user department "disagree" and 3.1% and 5.3 engineering non- management and user department "strongly disagree".

The mean shows that engineering management respondents "agree" (4), the engineering non-management and user departments are almost "neutral" (3.25) and (3.19) respectively.
From the standard deviation (0.632 for engineering management) it is clear that the management respondents have similar perception about the statement. But the engineering non-management and user department standard deviation (1.016) and (1.056) respectively with relatively lower mean indicates that they "neutral" with the statement.

When asked they agree or not with the statement "The engineering department skilled labor is satisfactory in terms of quantity (number) to accomplish preventive maintenance program", 16%

and 50% engineering management respond “strongly agree” and “agree” respectively. But non-management engineering respondents “strongly agree” only 6.25% and “agree”12.5%. Majority of them are “neutral”, “disagree” and “strongly disagree” 50%, 18.75% and 12.5% respectively. When the user department respondents reply evaluated, only 9.7% “strongly agree” and 22.6% agree with the statement while they respond 33.3% “neutral”, 23.7 % ”disagree”, and 10.8% “strongly disagree”.

The mean shows that engineering non-management and user departments respondents have the same and lower trust that the statement is true; engineering management 3.67, engineering non-management 2.81 and the user department 2.97 respectively. The standard deviation is 1.033, 1.03 and 1.137 for engineering management, engineering non-management and user departments respectively. From the result it is clear that all categories have dispersed idea about engineering department skilled labor to accomplish the preventive maintenance program.

Regarding to what extent respondents agree or disagree “the engineering teams are assigned to do preventive maintenance on their specialized knowledge”, 33.3% and 67.7% engineering management respondents say “strongly agree” and “agree” respectively which is a total of 100%. The response on the same issue from engineering non-management respondents revealed that only 9.4% 25% claimed “strongly agree” and “agree” respectively; the response from the user department is closely similar 11.8% “strongly agree” and 32.3% “agree”. Likewise, the result shows that 31% “neutral” 17% “disagree” and 4% “strongly disagree” for engineering non-management and for user departments 33.3% “neutral”, 18.3% “disagree” and 4.3% “strongly disagree”.

The mean result shows that engineering management “strongly agree” (4.33) but the engineering and user departments are almost “neutral” for the statement 3.16 and 3.29 respectively. The standard deviation is .0.516 for engineering management, 0.987 and 1.038 for engineering non-management and user department respondents respectively. The total result shows that the engineering management and others have different opinion on the same statement.

The manual state that, each associate that starts working in the hotel must be trained. A booklet with all the essential information can be printed for distribution to the associates, and over 25 training modules are available online.

Table 4.2.2: Summary of availability of special tools and training

	Question	measurement	Engineering management		Engineering non-management		User department	
			freq	%	freq	%	freq	%
1	The engineering department technicians have the necessary special tools to do the preventive maintenance program.	Strongly agree	0	0	1	3.1	11	11.8
		Agree	5	83.3	5	15.6	26	28
		Neutral	1	16.7	17	53.1	29	31.2
		Disagree	0	0	4	12.5	19	20.4
		Strongly disagree	0	0	5	15.6	8	8.6
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.78**		**3.14**	
		SD	**0.408**		**1.008**		**1.138**	
2	The hotel provides training to engineering team so that the preventive maintenance program is effective.	Strongly agree	1	16.7	2	6.3	7	7.5
		Agree	3	50	3	9.4	21	22.6
		Neutral	1	16.7	12	37.5	34	36.6
		Disagree	1	16.7	10	31.3	26	28
		Strongly disagree	0	0	5	15.6	5	5.4
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.59**		**2.989**	
		SD	**1.033**		**1.073**		**1.016**	

Source: (Own data, December 2017)

As indicated on item one of table 4.2.2, 83% engineering management "agree" to the statement the engineering department technicians have the necessary special tools to do the preventive maintenance program. Whereas 3.1% and 15.6% engineering non-management with 11.8% and 28% user department "strongly agree" and "agree" respectively. On the other hand none of the engineering management disagree with the statement but in the contrary, more than half engineering non-management respondents (53.1) and more than quarter (31.2%)user department respondents are neutral to the statement .Also 12.5% and 15.6% engineering non-management and 20.4% and 8.6% user department respondents "Disagree" and "Strongly disagree" with the

statement The mean is3.83 for engineering management, 2.78 for non-management and 3.14 for user departments. The standard deviation is 0.408, 1.008 and 1.138 for engineering management, non-management and user department respectively.

From the total result it is clear that engineering management strongly believe that it has provided special tools to technicians while the technicians does not believe they have the necessary special tools to do the preventive maintenance.

With respect of to the statement" The hotel provides training to engineering team so that the preventive maintenance program is effective." majority percentage (66.7%) of engineering management "strongly agree and agree" with the statement. In the opposite, only few (15.7%) engineering non- management "strongly agrees and agrees"with the statement.
In a similar difference while few (16.7%) management and almost half non-management (47%) "disagree "with the statement.

The mean is 3.67 for engineering management and 2.59 for the non-management. The standard deviation is almost equal (1.03 for management and 1.073 for non-management).
The result shows that there is opinion difference between management and non- management about preventive maintenance training.

When interview is conducted with the chief engineer, to the question, "How often do you train staff in relation to preventive maintenance? Do you give certificates to those who undergo training? He responded that Monthly training will be given on basic maintenance and preventive maintenance is part of this training. We will not give certificate for the trainees.

Table 4.2.3: Summary of availability of spare parts

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	All machines on preventive maintenance program have sufficient spare parts.	Strongly agree	1	16.7	1	3.1	4	4.3
		Agree	5	83.3	3	9.3	15	16.1
		Neutral	0	0	14	43.7	30	32.3
		Disagree	0	0	8	25	30	32.3
		Strongly disagree	0	0	6	18.75	14	15.1
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.53**		**2.62**	
		SD	**0.408**		**1.016**		**1.062**	
2	The spare parts used for machines to do preventive maintenance are durable and meet the quality standards.	Strongly agree	1	16.7	1	3.1	4	4.3
		Agree	5	83.3	4	12.5	15	16.1
		Neutral	0	0	15	46.9	30	32.3
		Disagree	0	0	7	21.9	30	32.3
		Strongly disagree	0	0	5	15.6	14	15.1
		Total	6	100	32	100	93	100
		Mean	**4.167**		**2.66**		**2.89**	
		SD	**0.408**		**1.004**		**1.078**	
3	The technicians feel free to order spare parts to perform preventive maintenance.	Strongly agree	3	50	2	6.25	5	5.4
		Agree	3	50	8	25	23	24.7
		Neutral	0	0	14	43.75	29	31.2
		Disagree	0	0	6	18.75	20	21.5
		Strongly disagree	0	0	2	6.25	16	17.2
		Total	6	100	32	100	93	100
		Mean	**4.5**		**3.06**		**2.79**	
		SD	**0.548**		**0.982**		**1.157**	

Source: (Own data, December 2017)

As indicated on item one and two of table 4.2.3, 100% engineering management "Strongly agree and Agree" to the statements "All machines on preventive maintenance program have sufficient spare parts" and "The spare parts used for machines to do preventive maintenance are durable

and meet the quality standards "with the same mean and standard deviation 4.17 and 0.408 respectively.

In the contrary, only few (almost 20% engineering non-management and user department) respondents have the same opinion to the statements. The mean for non-management and user departments is less than 3.00 and standard deviation similarly 1.

The total result it is clear that, there is a wide opinion difference between the management and the other departments about spare part availability and durability.

To the statement "The technicians feel free to order spare parts to perform preventive maintenance",
The engineering management respondents confirm 100% the statement is factual as usual. However, 31.5% engineering non-management and 30.1% user department respondents confirm the statement is accurate. Additionally, 43.75 non-management and 31.2 user department respondents reply "neutral".

The mean 4.5, 3.06 and 2.79 and standard deviation 0.548, 0.982 and 1.157 for management, non- management and user department respectively shows that there is variance in judgement of the statement.

As indicated above, 100% engineering management believe that there is enough, durable and quality spare parts to do the preventive maintenance. Additionally, when the chief engineer is asked the same question in the interview, he said that every material is available to perform the preventive maintenance for majority of machines and equipment not for all of them. But the result of the non-management and the user department is opposite to the management.
The manual recommend that, 71 types of spare parts for the guest room, 14 types of spare parts for public area and another 14 types of spare parts for back of the house should be kept for proper preventive maintenance practice.

Table 4.2.4: Summary of availability of maintenance instruction

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The hotel has dedicated and skilled preventive maintenance planner.	Strongly agree	1	16.7	1	3.1	8	8.6
		Agree	2	33.3	4	12.5	27	29
		Neutral	3	50	16	50	34	36.6
		Disagree	0	0	10	31.2	17	18.3
		Strongly disagree	0	0	1	3.1	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.81**		**3.13**	
		SD	**0.816**		**0.821**		**1.055**	
2	All Machines which has Preventive maintenance have instructions and procedures to do the preventive maintenance program.	Strongly agree	2	33.3	3	9.3	12	12.9
		Agree	3	50	4	12.5	35	37.6
		Neutral	1	16.7	17	53.1	29	31.2
		Disagree	0	0	5	15.6	15	16.1
		Strongly disagree	0	0	3	9.3	2	2.2
		Total	6	100	32	100	93	100
		Mean	**4.167**		**2.97**		**3.43**	
		SD	**0.753**		**1.031**		**0.982**	
3	The preventive maintenance instruction has safety procedure before starting a task.	Strongly agree	4	66.7	1	3.1	13	14
		Agree	1	16.7	7	21.9	30	32.3
		Neutral	1	16.7	19	59.4	32	34.4
		Disagree	0	0	4	12.5	15	16.1
		Strongly disagree	0	0	1	3.1	3	3.2
		Total	6	100	32	100	93	100
		Mean	**4.5**		**3.09**		**3.376**	
		SD	**0.837**		**0.777**		**1.021**	

Source: (Own data, December 2017)

When asked “The hotel has dedicated and skilled preventive maintenance planner”, equal 50% engineering management and non- management and 36.6% user department respond “neutral”. Remarkably, while no management “oppose” the statement, 34.3% non-management and 25.8% user department users differ from the idea.

The mean 3.67, 2.81and 3.13 and standard deviation 0.816, 0.821 and 1.055 for management, non- management and user department respectively shows that there is verify that the all the three group of respondents have diverse ideas on the same issue.

As it can be seen in table 4.2.4 statement 2 and 3, if all Machines which has Preventive maintenance have instructions and procedures to do the preventive maintenance program and if the procedure has included safety, majority (83%) management respondents are in agreement with the statement. To the contradictory, minority (less than 25%) engineering non-management and almost half (50%) user department respondents agree with the statements. To the same statement, while few (16.7%) management and more than half (50%) and almost 1/3 (33%) of user department respondents either agree or disagree with the statement.

With the same disqualify, the mean are more than 4 for management and 3 for engineering non-management and 3.5 user departments.

Based on the result, it can be seen that there is an opinion difference.
According to the manual, each property must have a documented planned/schedule preventative maintenance program in place for technical services.

Table 4.2.5: Summary of availability of time and qualified technicians

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Every technician is involved in the preventive maintenance planning and preparation.	Strongly agree	2	33.3	2	6.3	8	8.6
		Agree	1	16.7	3	9.4	23	24.7
		Neutral	2	33.3	17	53.1	33	35.5
		Disagree	1	16.7	8	25.0	24	25.8
		Strongly disagree	0	0	2	6.3	5	5.4
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.84**		**3.054**	
		SD	**1.211**		**0.92**		**1.036**	
2	There is enough available time to do preventive maintenance program.	Strongly agree	1	16.7	3	9.4	12	12.9
		Agree	3	50	4	12.5	32	34.4
		Neutral	1	16.7	15	46.9	26	28
		Disagree	1	16.7	5	15.6	17	18.3
		Strongly disagree	0	0	5	15.6	6	6.5
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.84**		**3.29**	
		SD	**1.033**		**1.139**		**1.109**	

Source: (Own data, December 2017)

As it can be on the above table, 50% of management confirm that the statement "Every technician is involved in the preventive maintenance planning and preparation" is accurate. Nevertheless few 15.7% non-management and 33.3% user department respondents believe the statement is accurate. Additionally equal number (31%) of non-management and user department respondents does not agree with the statement. The mean is 3.67, 2.84 and 3.054 for management, non-management and user departments respectively. The standard deviation is 1.211, 0.92 and 1.036 accordingly.

The result shows that, a number of the respondents in all categories are "neutral" to the statement "Every technician is involved in the preventive maintenance planning and preparation".

When asked, "There is enough available time to do preventive maintenance program", majority (66.7) management, few (22%) non- management and almost half (47%) user department agree with the statement. Surprisingly, almost the same percent (15-18%) respondents disagree with the statement.

The mean 3.67, 2.84 and 3.29 and standard deviation 1.033, 1.139 and 1.109 for engineering management, non- management and user department respondents respectively shows that there is while there is an opinion difference on the issue, the dispersion is similar.

Table 4.2.6: Summary of availability of personal protective equipment and feedback

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Every technician has personal protective equipment and feels safe to do the preventive maintenance program.	Strongly agree	2	33.3	1	3.1	8	8.6
		Agree	4	66.7	5	15.6	32	34.4
		Neutral	0	0	15	46.9	30	32.3
		Disagree	0	0	9	28.1	17	18.3
		Strongly disagree	0	0	2	6.3	6	6.5
		Total	6	100	32	100	93	100
		Mean	**4.33**		**2.81**		**3.204**	
		SD	**0.516**		**0.896**		**1.048**	
2	The engineering department supervisors provide timely feedback to employees about preventive maintenance performance.	Strongly agree	1	16.67	2	6.06	11	11.83
		Agree	2	33.33	12	36.36	35	37.63
		Neutral	3	50.00	13	39.39	24	25.81
		Disagree	0	0.00	3	9.09	18	19.35
		Strongly disagree	0	0.00	3	9.09	5	5.38
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.5**		**2.806**	
		SD	**0.816**		**0.95**		**1.135**	

Source: (Own data, December 2017)

How employees felt comfortable with the statement "Every technician has personal protective equipment and feels safe to do the preventive maintenance program" is another debatable issue among employees.

While 100% management believe that the statement is truthful, only few non-management (less than 20%) and less than half (43%) believe that the statement is truthful.

The mean 4.33, 2.81 and 3.204 with standard deviation 0.516, 0.896 and 1.048 for management, non- management and user department correspondingly is an evidence for the issue.

As it can be observed on question two on table 4.2.6, while the management 50% believe that they are providing timely feedback. Similarly, 42% engineering non-management and 50% user department respond similar to the management. The mean and standard deviation show that non-management and user department has related idea while the management has different opinion. The manual states it is a must to wear personal protective equipment (PPE) when doing any kind of maintenance.

Table 4.2.7: Summary of use of computer inventory system

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The hotel is using computerized inventory system.	Strongly agree	1	16.7	2	6.2	12	12.9
		Agree	3	50	6	18.7	33	35.5
		Neutral	2	33.3	12	37.5	24	25.8
		Disagree	0	0	7	21.8	18	19.4
		Strongly disagree	0	0	5	15.6	6	6.5
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.78**		**3.29**	
		SD	**0.753**		**1.128**		**1.119**	
2	The inventory system is integrated with other preventive maintenance systems.	Strongly agree	0	0	0	0	9	9.7
		Agree	2	33.3	3	9.37	15	16.1
		Neutral	4	66.7	12	37.5	33	35.5
		Disagree	0	0	7	21.8	29	31.2
		Strongly disagree	0	0	10	31.2	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.33**		**2.25**		**2.89**	
		SD	**0.516**		**1.016**		**1.078**	
3	The inventory system is used to calculate preventive maintenance cost.	Strongly agree	1	16.7	1	3.125	12	12.9
		Agree	1	16.7	5	15.625	18	19.4
		Neutral	4	66.7	14	43.75	38	40.9
		Disagree	0	0	6	18.75	21	22.6
		Strongly disagree	0	0	6	18.75	4	4.3
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.66**		**3.14**	
		SD	**0.837**		**1.066**		**1.049**	

Source: (Own data, December 2017)

In relation to the statement "The hotel is using computerized inventory system" 66.7% management and 48.4% user department and 25% non-management believe that the statement is correct and nearly the same percent of all department respondents are "neutral". The mean and the standard deviations vary accordingly (3.83, 0.753 for engineering management, 2.78,1.128 for non-management and 3.29, 1.119 for user departments). The result confirms that there is opinion difference on this topic.

With respect to item 2, table 4.2.7, “The inventory system is integrated with other preventive maintenance systems”, majority (66.7%) management reply “neutral” and only 33.3% agree with the statement. The mean and standard deviation is 3.33 and 0.516; which reveals that the management has the almost same idea. When the others are observed, only few(9.37%) agree from engineering non- management and quarter (25.8%). The result shows that majority from all categories of respondents does not agree the statement is realistic.

Regarding to what extent the respondents agree or not the inventory system is used to calculate preventive maintenance cost, majority (66.7%) management are “neutral” and similar percent 41% and 44%non-management and user department respondents are “neutral”. While there is no respondent from management disagree, 37.5% non-management and 27% user department respondents disagree with the statement. When the mean is observed, the management and user department respondents have more or less the same judgment to the statement while the non-management judgment is lower.

The manual states that, the preventive maintenance management program must aim to have 90% of machines and equipment to be loaded in the inventory system.

Table 4.2.8: Summary of obsolete spare parts indication

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The inventory system can indicate how many spare parts and consumables are consumed in each machine	Strongly agree	2	33.3	2	6.3	8	8.6
		Agree	3	50	2	6.3	21	22.6
		Neutral	0	0	17	53.1	39	41.9
		Disagree	1	16.7	8	25	24	25.8
		Strongly disagree	0	0	3	9.3	1	1.1
		Total	6	100	32	100	93	100
		Mean	**4**		**2.75**		**3.12**	
		SD	**1.095**		**0.95**		**0.931**	
2	The hotel has a system to avoid machines which are obsolete or out of operation.	Strongly agree	1	16.7	1	3.1	7	7.5
		Agree	3	50	3	9.4	21	22.6
		Neutral	2	33.3	14	43.8	26	28
		Disagree	0	0	8	25	23	24.7
		Strongly disagree	0	0	6	18.75	16	17.2
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.53**		**2.79**	
		SD	**0.075**		**1.016**		**1.196**	
3	The inventory system is capable of identifying spare parts obsolesce (No more available).	Strongly agree	0	0	1	3.1	9	9.7
		Agree	2	33.3	4	12.5	15	16.1
		Neutral	4	66.7	10	31.3	33	35.5
		Disagree	0	0	11	34.4	19	31.2
		Strongly disagree	0	0	5	15.6	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.33**		**2.52**		**3**	
		SD	**0.516**		**1.029**		**1.048**	

Source: (Own data, December 2017)

As indicated on the above table 4.2.8, when asked “The inventory system can indicate how many spare parts and consumables are consumed in each machine” majority of management (83.3) reply they statement is truthful. When conducted interview with the chief engineer, he also respond that there is a system which support the statement.

However, very few 12.6% non-management and less than quarter 21.2% user department respondents reply the statement is truthful. In the contrary, 53% and 34% non-management respondents reply “Neutral” and “disagree” respectively. Similarly 41.9% and 26.9% user department respondents reply “Neutral” and “disagree” respectively. With the mean 4, 2.75 and 3.12 management and non-management and user department respectively and almost similar standard deviation(1) one can judge that both category of respondents have a difference of picture about whether the inventory system can indicate how many spare parts and consumables are consumed in each machine or not.

As it can be seen in statement 2 and 3 on the above table, weather they agree or not to the statements “The hotel has a system to avoid machines and spare parts which are obsolete or out of operation”, not a single management respondent differ from the statement. In the contrary minority (almost 25%) respondents from non-management and user department believe the statement is factual. The mean and standard deviation also shows that the non-management and user departments have similar opinion while the engineering management differs.
As indicated in the manual, the property Engineer is required to complete the self-audit in September each year.

Table 4.2.9: Summary of availability of machine master list and document updating

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The preventive maintenance documents and manuals are updated whenever there are machines and equipment are bought and replaced.	Strongly agree	0	0	1	3.1	8	8.6
		Agree	4	66.7	2	6.2	24	25.8
		Neutral	1	16.7	18	56.2	30	32.3
		Disagree	0	0	6	18.7	23	24.7
		Strongly disagree	1	16.7	5	15.6	8	8.6
		Total	6	100	32	100	93	100
		Mean	**3.33**		**2.63**		**3**	
		SD	**1.211**		**0.942**		**1.098**	
2	The hotel has a master machines and equipment list that needs preventive maintenance.	Strongly agree	2	33.3	1	3.1	7	7.5
		Agree	3	50	3	9.3	24	25.8
		Neutral	1	16.7	12	37.5	34	36.6
		Disagree	0	0	11	34.3	19	20.4
		Strongly disagree	0	0	5	15.6	9	9.7
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.5**		**3**	
		SD	**0.753**		**0.984**		**1.078**	
3	The hotel has grouped machines according to their function (e.g.. Power generation and distribution, water treatment, pumps, fire and safety…etc.)	Strongly agree	2	33.3	2	6.3	13	14
		Agree	3	50	9	28.1	38	40.9
		Neutral	1	16.7	18	56.3	29	31.2
		Disagree	0	0	2	6.3	13	14
		Strongly disagree	0	0	1	3.1	0	0
		Total	6	100	32	100	93	100
		Mean	**4.17**		**3.28**		**3.56**	
		SD	**0.753**		**0.813**		**0.903**	

Source: (Own data, December 2017)

When asked “The preventive maintenance documents and manuals are updated whenever there are machines and equipment are bought and replaced”, majority engineering management (66.7%) accepts that the statement is accurate. The interview with the chief engineer also shows that, preventive maintenance manuals and documents are updated whenever machines are bought and replaced. In addition to that, the updated documents are stored where everyone get access.
On the other hand, only 10% non- management and 34% user department agree with the statement.
The total result from the mean and standard deviation revels that the issue is very arguable.

As indicated in table 4.2.9, item 2 and 3, whether they agree or not to the statements “The hotel has a master machines and equipment list that needs preventive maintenance” and “The hotel has grouped machines according to their function” the management respondents reply the same (83.3%) the statement is truthful, with the same mean (4.17) and standard deviation (0.753).
On the opposite side, less than half of the non-management and user department respondents tell that the statement is true. As it can be seen on the mean and standard deviation are around 3 and 1 reactively. The result suggests that non-management and user department has dissimilar opinion from the management.

As per the manual, annual maintenance records must be “signed off” annually by both the General Manager and property Engineer. The Property Engineer should present the file for GM sign off in January each year. A hard copy must be retained on file for 5 years.

Table 4.2.10: Summary of availability of qualified inventory personnel

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The hotel has a numbering system for every machine for identification.	Strongly agree	2	33.3	3	9.4	12	12.9
		Agree	3	50	4	12.5	30	32.3
		Neutral	0	0	18	56.3	27	29
		Disagree	1	16.7	5	15.6	19	20.4
		Strongly disagree	0	0	2	6.3	5	5.4
		Total	6	100	32	100	93	100
		Mean	**4**		**3.03**		**3.27**	
		SD	**1.095**		**0.967**		**1.095**	
2	There are skilled and experienced personnel that perform machines and spare parts inventory for preventive maintenance program.	Strongly agree	0	0	0	0	9	9.7
		Agree	3	50	3	9.4	24	25.8
		Neutral	3	50	16	50.0	27	29
		Disagree	0	0	9	28.1	26	28
		Strongly disagree	0	0	4	12.5	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.56**		**3.03**	
		SD	**0.548**		**0.84**		**1.113**	
3	The hotel has periodic machine and equipment inventory update.	Strongly agree	1	16.7	1	3.1	7	7.5
		Agree	2	33.3	2	6.3	22	23.7
		Neutral	3	50	17	53.1	29	31.2
		Disagree	0	0	7	21.9	27	29
		Strongly disagree	0	0	5	15.6	8	8.6
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.59**		**2.96**	
		SD	**0.816**		**0.946**		**1.086**	

Source: (Own data, December 2017)

In relation to item one of table 4.2.10, to what extent respondents say "The hotel has a numbering system for every machine for identification", majority of management (83.3%), minority (22%) non-management and near half (45.2%) accept the statement. More or less similar percent does not accept the statement (16.7% from engineering management, 22.3% non-management and 25.8% from user department).
The chief engineer also agrees with the management respondents. He said that the hotel has a numbering system for every machine.

The standard deviation 1 for all categories and mean of 4 for management and 3 for the non-management shows that all respondents have diverse judgment on the issue.
Regarding to what extent the respondents agree or not to the statement "There are skilled and experienced personnel that perform machines and spare parts inventory for preventive maintenance program", the engineering management has divided 50 -50 between "agree" and Neutral". Whereas the non-management response was 50% "neutral" 10% "agree" and 40 "Disagree". When the user department result is seen 35.5% "agree", 29% "neutral" and 35.5% "disagree". The mean and standard deviation is 3.5, 0.548 for engineering management,2.56, 0.84 for non-management and 3.03,1.113 for user department. One can say that there is different believe between all categories.

When asked if the hotel has periodic machine and equipment inventory update, the engineering management reply 50-50 as the statement. But very few (9.4%) non-management and less than 1/3 (30%) user department respondents agree and equal amount of non-management and user department respondents (37.6%) differ from the statement. While the management respondent mean is greater (3.67) and the others almost similar and lower (2.6 and 2.9) the standard deviation reveals that the ideas of all categories is diverse.

As indicated in the manual, due to the changing technology and diverse complexity of equipment, highly specialized personnel are required for major machines and equipment.

Table 4.2.11: Summary of availability of periodic spare part inventory

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	There is enough spare parts inventory to do preventive maintenance program.	Strongly agree	2	33.3	1	3.1	8	8.6
		Agree	1	16.7	3	9.3	22	23.7
		Neutral	3	50	14	43.7	30	32.3
		Disagree	0	0	9	28.1	22	23.7
		Strongly disagree	0	0	5	15.6	11	11.8
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.56**		**2.96**	
		SD	**0.983**		**0.982**		**1.14**	
2	All spare parts inventory for preventive maintenance are accountable for price.	Strongly agree	2	33.3	1	3.1	8	8.6
		Agree	2	33.3	4	12.5	22	23.7
		Neutral	2	33.3	13	40.6	32	34.4
		Disagree	0	0	7	21.8	21	22.6
		Strongly disagree	0	0	7	21.8	10	10.8
		Total	6	100	32	100	93	100
		Mean	**4**		**2.53**		**2.97**	
		SD	**0.894**		**1.077**		**1.118**	
3	The hotel has spare part inventory periodically which are used for preventive maintenance.	Strongly agree	1	16.7	1	3.1	5	5.4
		Agree	5	83.3	2	6.2	22	23.7
		Neutral	0	0	15	46.8	30	32.3
		Disagree	0	0	7	21.8	22	23.7
		Strongly disagree	0	0	7	21.875	14	15.1
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.47**		**2.806**	
		SD	**0.408**		**1.016**		**1.125**	

Source: (Own data, December 2017)

In relation to the statement “There is enough spare parts inventory to do preventive maintenance program”, the engineering management divided into agreement and neutrality in 50-50. The non-management result reveals that 12.4% agree, and the rest is divided equally between neutrality and disagreement (43.5% each).When we reveal the user department result, it is divided almost equally 33% between agreement, neutrality and disagreement. The mean 3.8 for management, 2.5 for non- management and 3 for user department with comparable standard deviation (almost 1) one can say the subject is very controversial.

To the statement “All spare parts inventory for preventive maintenance are accountable for price”, the management respondents are equally divided 33% to “strongly agree”, “agree” and “neutral”. The mean and standard deviation is 4 and 0.89 for this group. When the non-management respondents reveled, it is divided 43% disagree, 41% neutral and only 16% agree with mean and standard deviation 2.53 and 1.077.

When the user department respondents observed, it is 33.4 disagree, 34.4 neutral and 32.3 agree with mean 3 and standard deviation 1.1. It is clear from the result that the management believes that the statement is a fact while the other respondents think differently.

When asked “The hotel has spare part inventory periodically which are used for preventive maintenance” 100% management respondents agree with the statement. Despite the fact that the management respondents reply that, only 10% non-management respondents agree with the fact. The mean 4.17 and 2.47 and standard deviation 0.408 and 1.016 clearly show that there is wide picture difference on the same issue.

Table 4.2.12: Summary of accessibility of computerized work order

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Computerized work order system is in place to allow effective management of preventive maintenance work.	Strongly agree	2	33.3	2	6.2	15	16.1
		Agree	2	33.3	3	9.3	33	35.5
		Neutral	2	33.3	18	56.2	26	28
		Disagree	0	0	5	15.6	15	16.1
		Strongly disagree	0	0	4	12.5	4	4.3
		Total	6	100	32	100	93	100
		Mean	**4**		**2.81**		**3.43**	
		SD	**0.894**		**0.998**		**1.077**	
2	The computer maintenance system is able to detect potential preventive maintenance problems by examining history	Strongly agree	2	33.3	1	3.1	9	9.7
		Agree	1	16.7	4	12.5	22	23.7
		Neutral	2	33.3	9	28.1	26	28
		Disagree	1	16.7	13	40.6	29	31.2
		Strongly disagree	0	0	5	15.6	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.47**		**2.97**	
		SD	**1.211**		**1.016**		**1.118**	
3	The hotel has consistently keeps preventive maintenance records in computerized maintenance management system	Strongly agree	3	50	2	6.25	11	11.8
		Agree	3	50	5	15.625	24	25.8
		Neutral	0	0	19	59.375	32	34.4
		Disagree	0	0	4	12.5	18	19.4
		Strongly disagree	0	0	2	6.25	8	8.6
		Total	6	100	32	100	93	100
		Mean	**4.5**		**3.03**		**3.13**	
		SD	**0.548**		**0.897**		**1.125**	

Source: (Own data, December 2017)

To the statement “Computerized work order system is in place to allow effective management of preventive maintenance work”, the management respondents reply 33% for “strongly agree”, “agree” and “neutral”. For the same statement only 15.8% agree and 56.2% neutral and 28.1% “disagree”, and the user department almost half (51.6%) respond “agree”, 38.7% “disagree” and the 28% “neutral”. From the mean 4, 2.8 and 3.4 for management, non-management and user department and standard deviation almost the same (1) one can see that the opinion difference in all respondents on the same subject matter.

In relation to the statement “The computer maintenance system is able to detect potential preventive maintenance problems by examining history”, 50% management respondents believe the statement is correct and 16.7% believe the statement is wrong. To the opposite 56.2% non - management believe that the statement is wrong and 15.6% believe that the statement is correct.

The interview with the chief engineer shows that the system is there but not practiced well.
With the mean 3.67 and 2.47 for engineering management and non-management, this is another judgment difference within the same department.

Based on the analysis in the above table point 3, the statement “The hotel has consistently keeps preventive maintenance records in computerized maintenance management system” is another controversial issue. As the result shows, while 100% management agree with the statement, less than quarter (22%) non-management and almost 1/3 (37) of user department respondents agree the statement is true. From the mean 4.5 for management and almost 3 for non-management and user department respondents, it is clear that the management opinion is different from others.
The manual states that, by using computerized maintenance system, properties can plan daily preventive maintenance accordingly. This helps prevent excessive backlog. The preventive maintenance Calendar shows future preventive maintenance tasks including parts and hours required to assist in planning.

Table 4.2.13: Summary of familiarity of engineering personnel with the computer system

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The preventive maintenance program is integrated with environment, health and safety program by computer system.	Strongly agree	1	16.7	1	3.125	10	10.75
		Agree	2	33.3	1	3.125	15	16.13
		Neutral	2	33.3	10	31.25	31	33.33
		Disagree	1	16.7	13	40.625	26	27.96
		Strongly disagree	0	0	7	21.875	11	11.83
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.25**		**2.86**	
		SD	**1.049**		**0.95**		**1.157**	
2	Technicians and supervisors are familiar with computer maintenance management system.	Strongly agree	2	33.3	2	6.2	10	10.8
		Agree	1	16.7	2	6.2	21	22.6
		Neutral	3	50	12	37.5	34	36.6
		Disagree	0	0	9	28.1	20	21.5
		Strongly disagree	0	0	7	21.8	8	8.6
		Total	6	100	32	100	93	100
		Mean	**3.833**		**2.47**		**3.05**	
		SD	**0.983**		**1.107**		**1.107**	
3	The computer maintenance management system gives priority for very important machines.	Strongly agree	3	50	1	3.125	15	16.1
		Agree	2	33.3	5	15.625	21	22.6
		Neutral	0	0	12	37.5	28	30.1
		Disagree	1	16.7	12	37.5	28	30.1
		Strongly disagree	0	0	2	6.25	1	1.1
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.72**		**3.27**	
		SD	**1.169**		**0.924**		**1.085**	

Source: (Own data, December 2017)

As it can be seen on table 4.2.13 point 1, when asked, “The preventive maintenance program is integrated with environment, health and safety program by computer system” almost all department respondents say 33% ‘neutral”. While 50% management respondents agree with the statement, only few (6%) non-management and 27% user department respondents agree with the statement. The mean 3.5, 2.25 and 2.86 for management, non-management and user department respondents respectively shows that, the management and other respondents have disagreement in the topic.

When asked “Technicians and supervisors are familiar with computer maintenance management system” the management respondents are divided between agreement and neutrality 50-50. For the same statement only 12% non-management and 33% user department users agree.
Half (50%) and 28% non-management and user department respondents disagree to the statement. The total result revels that there is a wide view difference.

The statement “The computer maintenance management system gives priority for very important machines” is another very arguable issue in the hotel. While majority (83%) management has confidence that the statement is true, only 19% non-management and 39% user department respondents trust the statement is true.

When we see the mean and standard deviation, it is clear that there is extensive opinion difference on the topic.

As mentioned in the manual, it is the chief engineer’s duty to schedule on the job training and skills reinforcement plan in place for each engineering staffs. And the training should be integrated with environment, health and safety program.

Table 4.2.14: Summary of availability of central maintenance command center

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Computer maintenance management system is used to order spare parts and consumables for the preventive maintenance program.	Strongly agree	1	16.7	3	9.375	12	12.9
		Agree	2	33.3	3	9.375	29	31.2
		Neutral	2	33.3	8	25	34	36.6
		Disagree	1	16.7	13	40.625	15	16.1
		Strongly disagree	0	0	5	15.625	3	3.2
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.56**		**3.34**	
		SD	**1.049**		**1.162**		**1.005**	
2	The computer maintenance system is a major tool to decide machines replacement.	Strongly agree	2	33.3	2	6.25	14	15.1
		Agree	1	16.7	4	12.5	23	24.7
		Neutral	2	33.3	10	31.25	27	29.0
		Disagree	0	0	10	31.25	22	23.7
		Strongly disagree	1	16.7	6	18.75	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.56**		**3.16**	
		SD	**1.517**		**1.134**		**1.173**	
3	There is a well-equipped computerized preventive maintenance command center in the hotel.	Strongly agree	3	50	1	3.125	10	10.8
		Agree	3	50	5	15.625	20	21.5
		Neutral	0	0	14	43.75	32	34.4
		Disagree	0	0	6	18.75	21	22.6
		Strongly disagree	0	0	6	18.75	10	10.8
		Total	6	100	32	100	93	100
		Mean	**4.5**		**2.66**		**2.99**	
		SD	**0.548**		**1.066**		**1.147**	

Source: (Own data, December 2017)

As indicated on table 4.2.14, point 1 and 2, “Computer maintenance management system is used to order spare parts and consumables for the preventive maintenance program” and “The computer maintenance system is a major tool to decide machines replacement” the management and user department respondents is similar (almost 50% agree) while the non- management differ with only 19% agree with the statement. When the mean and standard deviation is analyzed, management and user department are similar and non- management respondents disagree with the statement.

To the same question, “the computer maintenance system is a major tool to decide machines replacement” he replies that the statement is not correct.

The statement “There is a well-equipped computerized preventive maintenance command center in the hotel” is another debatable topic. While 100% management agree with the statement, in the contrary only few (19%) non-management and 32% user department respondents agree with the statement. The mean 4.5 for management and 2.66 and 3 for the non-management and user department respondents is a clear indication of how far the opinion is debatable.

The manual mentioned that the computer command center is intended to maintain high standards, and improve the condition of the hotel areas.

Table 4.2.15: Summary of usage of computer maintenance system to measure efficiency

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Preventive maintenance jobs are well planned in advance in the computer system.	Strongly agree	2	33.3	2	6.25	8	8.6
		Agree	3	50	4	12.5	28	30.1
		Neutral	1	16.7	13	40.625	35	37.6
		Disagree	0	0	7	21.875	17	18.3
		Strongly disagree	0	0	6	18.75	5	5.4
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.66**		**3.18**	
		SD	**0.753**		**1.125**		**1.01**	
2	Soft copy of documents and manuals are readily available in the computer system for preventive maintenance activities.	Strongly agree	2	33.3	2	6.25	8	8.6
		Agree	2	33.3	4	12.5	25	26.9
		Neutral	2	33.3	13	40.625	32	34.4
		Disagree	0	0	6	18.75	21	22.6
		Strongly disagree	0	0	7	21.875	7	7.5
		Total	6	100	32	100	93	100
		Mean	**4**		**2.63**		**3.07**	
		SD	**0.894**		**1.157**		**1.071**	
3	The computer maintenance management system records machine down time to measure efficiency.	Strongly agree	2	33.3	2	6.25	5	5.4
		Agree	1	16.7	4	12.5	25	26.9
		Neutral	2	33.3	8	25	33	35.5
		Disagree	0	0	13	40.625	23	24.7
		Strongly disagree	1	16.7	5	15.625	7	7.5
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.53**		**2.98**	
		SD	**1.517**		**1.107**		**1.021**	

Source: (Own data, December 2017)

As indicated on table 4.2.15, point 1 and 2, majority of management respondents believe the statements “Preventive maintenance jobs are well planned in advance in the computer system” and “Soft copy of documents and manuals are readily available in the computer system for preventive maintenance activities” are accurate, in the opposite only 19% non-management and almost 35% user department respondents accept the statement is accurate. The mean and standard deviation results also prove that the opinion of the management is different from others.

When asked “The computer maintenance management system records machine down time to measure efficiency” the management respondents are divided in 50% to 33% between agreement and neutrality and the rest 17% disagree with the statement. To the contrary almost half (56%) non-management respondents did not agree with the statement and the user department respondents are divided 33% between agreement, neutrality and disagreement. The fact of diverse opinion difference is also shown in the result of mean and standard deviation.

In the interview, the chief engineer replies that there is no computer maintenance management system that records machine down time to measure efficiency.

Table 4.2.16: Summary of the computer maintenance system to get feedback

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The system generates report to technicians to evaluate and get feedback their efficiency.	Strongly agree	2	33.3	1	3.1	6	6.5
		Agree	3	50	5	15.6	21	22.6
		Neutral	1	16.7	11	34.4	32	34.4
		Disagree	0	0	12	37.5	28	30.1
		Strongly disagree	0	0	3	9.4	6	6.5
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.66**		**2.93**	
		SD	**0.753**		**0.971**		**1.024**	
2	Preventive maintenance program efficiency is calculated and given to engineering management consistently.	Strongly agree	1	16.7	2	6.3	11	11.8
		Agree	2	33.3	3	9.4	22	23.7
		Neutral	2	33.3	10	31.3	31	33.3
		Disagree	1	16.7	11	34.4	23	24.7
		Strongly disagree	0	0	6	18.8	6	6.5
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.5**		**3.1**	
		SD	**1.049**		**1.107**		**1.104**	
3	Quality of preventive maintenance planning met the objective by using maintenance management system.	Strongly agree	2	33.3	1	3.1	7	7.5
		Agree	1	16.7	4	12.5	26	28.0
		Neutral	3	50	15	46.8	35	37.6
		Disagree	0	0	9	28.1	20	21.5
		Strongly disagree	0	0	3	9.375	5	5.4
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.72**		**3.108**	
		SD	**0.983**		**0.924**		**1.005**	

Source: (Own data, December 2017)

As it can be seen on table 4.2.16, point 1, 83% management accepts that the statement "The system generates report to technicians to evaluate and get feedback their efficiency" is factual, as usual only 19% non- management and 29% user department respondents accepts that the statement is factual. Almost 40% non-management and user department respondents believe the statement is not factual. The difference in mean result 4.17 for management and 2.66 and 2.93 for non-management and user departments is a witness for how the difference in judgment appears.

When asked "Preventive maintenance program efficiency is calculated and given to engineering management consistently" equal percentage (33%) of all respondents is "neutral" to the statement. Additionally almost half (53%) non-management and 30% user department respondents disagree with the statement. In the contrary 50% of the management agree with the statement. Equal standard deviation (more than 1) in all categories can indicate the diverse opinion in the subject matter.

To the statement "Quality of preventive maintenance planning met the objective by using maintenance management system", almost half of the respondents from all categories are "Neutral". But 50% of the management believes that the statement is true while 15% of non-management believe the statement is correct. The mean and equal standards deviation (1) shows that there is opinion difference on the statement. In the contrary, the chief engineer's response to the same question was he believes that the preventive maintenance program met the objective.

As indicated in the manual, computer based planned preventive maintenance is one way of obtaining good management of maintenance services, enabling manpower to be deployed effectively and economically and avoiding, as far as possible, breakdowns in essential services which have to be rectified at high cost. And every technician should get appropriate feedback.

Table 4.2.17: Summary of management commitment for the preventive maintenance

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The hotel management is committed for preventive maintenance execution.	Strongly agree	2	33.3	1	3.1	8	4.3
		Agree	2	33.3	4	12.5	25	32.3
		Neutral	1	16.7	15	46.9	33	31.2
		Disagree	1	16.7	7	21.9	17	20.4
		Strongly disagree	0	0	5	15.6	9	11.8
		Total	6	100	32	100	93	100
		Mean	**3.83**		**2.66**		**2.97**	
		SD	**1.169**		**1.004**		**1.088**	
2	The hotel uses comprehensive written preventive maintenance strategy that guides planning for maintenance management.	Strongly agree	2	33.3	1	3.1	7	7.5
		Agree	2	33.3	5	15.6	32	34.4
		Neutral	1	16.7	16	50.0	35	37.6
		Disagree	1	16.7	8	25.0	18	19.4
		Strongly disagree	0	0	2	6.3	1	1.1
		Total	6	100	32	100.0	93	100
		Mean	**3.83**		**2.84**		**3.28**	
		SD	**1.169**		**0.884**		**0.901**	
3	The hotel organizational structure is convenient for implementing preventive maintenance program.	Strongly agree	2	33.3	2	6.3	9	9.7
		Agree	3	50	5	15.6	31	33.3
		Neutral	1	16.7	13	40.6	35	37.6
		Disagree	0	0	12	37.5	15	16.1
		Strongly disagree	0	0	0	0.0	3	3.2
		Total	6	100	32	100	93	100
		Mean	**4.17**		**2.91**		**3.3**	
		SD	**0.753**		**0.893**		**0.964**	

Source: (Own data, December 2017)

As it can be seen on table 4.2.17, point 1 and 2, when asked “The hotel management is committed for preventive maintenance execution.” And “The hotel uses comprehensive written preventive maintenance strategy that guides planning for maintenance management.” 66% management respondents believe the statement is true. On the opposite side, very few (less than 20%) non-management respondents agree that the statement is factual and 50% are neutral. whereas when one sees the user department respondents’ result almost 40% believe that the statement is true.

The mean and standard deviation results show that all categories of respondents have different point of view in these statements.

The statement “The hotel organizational structure is convenient for implementing preventive maintenance program.” is another controversial topic. While 83% of management believes that the statement is truthful, only 21% non-management and 43% user department believe it is true. The mean 4.17, 2.91 and 3.3 for management, non-management and user department respondents respectively shows that how wide their difference is.

As stated in the manual, an unscheduled walk through should be carried out by Hotel Management every 3 to 4 months with a member of the Engineering team to evaluate the maintenance status of each machine.

Table 4.2.18: Summary of engineering department structure to do preventive maintenance

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The overall structure of the engineering department is logical to accomplish preventive maintenance program.	Strongly agree	2	33.3	2	6.3	8	8.6
		Agree	2	33.3	2	6.3	25	26.9
		Neutral	2	33.3	14	43.8	33	35.5
		Disagree	0	0	10	31.3	17	18.3
		Strongly disagree	0	0	3	9.4	9	9.7
		Total	6	100	32	100	93	100
		Mean	**4**		**2.68**		**3.07**	
		SD	**0.894**		**0.979**		**1.097**	
2	The responsibility of every person in the engineering department is clearly defined.	Strongly agree	3	50	2	6.3	7	7.5
		Agree	3	50	4	12.5	28	30.1
		Neutral	0	0	18	56.3	38	40.9
		Disagree	0	0	6	18.8	16	17.2
		Strongly disagree	0	0	2	6.3	4	4.3
		Total	6	100	32	100	93	100
		Mean	**4.5**		**2.94**		**3.19**	
		SD	**0.548**		**0.914**		**0.958**	
3	The engineering department preventive maintenance activities have constant nature.	Strongly agree	2	33.3	2	6.2	5	5.4
		Agree	3	50	4	12.5	20	21.5
		Neutral	1	16.7	13	40.6	29	31.2
		Disagree	0	0	9	28.1	25	26.9
		Strongly disagree	0	0	4	12.5	14	15.1
		Total	6	100	32	100	93	100
		Mean	**4.17**		**3.66**		**2.75**	
		SD	**0.753**		**1.054**		**1.12**	

Source: (Own data, December 2017)

To the statement “The overall structure of the engineering department is logical to accomplish preventive maintenance program”, 66% management respondents agree with 33% “neutral”. On the other hand only 12% non-management “agree” to the statement and 44% “neutral” and the rest 40% “disagree” with the statement. When we see the respondents of the user department it is almost equally divided 33% in agreement, neutrality and disagreement.

As usual, the mean and standard deviation difference shows that there is dissimilarity on the statement.

As easily seen in table 4.2.18, point 2, 100% management agree to the statement “The responsibility of every person in the engineering department is clearly defined.” Surprisingly only 19% non-management 38% user department respondents agree to the statement. For the same question 56% non-management and 41% user department respondents are “neutral”.
When asked, “The engineering department preventive maintenance activities have constant nature.” 83% management respondents believe that the statement is realistic. However only 19% non-management and 27% user department respondents believe that the statement is realistic. Unsurprisingly, while there is no management respondent disagree with the statement, almost 40% non-management and user department disagree with the statement.

The manual state that the Chief Engineer is directly responsible for all Property Operations, Maintenance and Energy control for the hotel. Also it very important that the chief engineer to have a realistic appreciation of the skill set required to successfully manage the hotel engineering function.

Table 4.2.19: Summary of dependability of engineering personnel

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The engineering department teams are dependable in handling preventive maintenance program.	Strongly agree	1	16.7	2	6.2	3	3.2
		Agree	2	33.3	4	12.5	33	35.5
		Neutral	3	50	16	50	38	40.9
		Disagree	0	0	8	25	15	16.1
		Strongly disagree	0	0	2	6.2	4	4.3
		Total	6	100	32	100	93	100
		Mean	**3.67**		**2.88**		**3.172**	
		SD	**0.816**		**0.942**		**0.892**	
2	All critical machines and equipment have preventive maintenance.	Strongly agree	2	33.3	1	3.1	7	7.5
		Agree	4	66.7	5	15.6	25	26.9
		Neutral	0	0	20	62.5	36	38.7
		Disagree	0	0	4	12.5	19	20.4
		Strongly disagree	0	0	2	6.25	6	6.5
		Total	6	100	32	100	93	100
		Mean	**4.33**		**2.97**		**3.09**	
		SD	**0.516**		**0.822**		**1.018**	
3	The hotel sets priorities for preventive maintenance activities.	Strongly agree	3	50	1	3.1	6	6.5
		Agree	1	16.7	3	9.4	32	34.4
		Neutral	1	16.7	14	43.8	30	32.3
		Disagree	1	16.7	9	28.1	15	16.1
		Strongly disagree	0	0	5	15.6	10	10.8
		Total	6	100	32	100	93	100
		Mean	**4**		**2.56**		**3.1**	
		SD	**1.265**		**0.982**		**1.094**	

Source: (Own data, December 2017)

To the statement “The engineering department teams are dependable in handling preventive maintenance program” those management who claim “Strongly agree” ,“agree” and “neutral” are 16.7%, 33.3% and 50% respectively, there is no one “disagree” . Whereas from the non-management respondents 50% are neutral, few (18.7%) accept the statement and almost 1/3 (31%) decline the statement. From the user department, who accept and neutral 40% each and the rest 20% decline the statement.

The mean for management and user department respondents are 3.67 and 3.2 respectively. But the mean for the non-management is 2.88.

Regarding the statement “All critical machines and equipment have preventive maintenance”, 100% engineering management accept the statement, whereas from the non- management majority (more than 60%) are “neutral” and the rest accept and disqualify the statement almost equally 20% each. When the user department result is seen 34% accept, 38% are neutral and the rest 28% disagree with the statement.

The mean and standard deviation 4.33, 0.516 for management, 2.97, 0.822 for non-management and 3.09, 1.018 revels that the while management respondents has similar opinion the rest are dispersed in idea.

To the statement “The hotel sets priorities for preventive maintenance activities”, 66.7% management agrees. To the other hand 12.5% non-management and 40.9% user department respondents agree.

The mean is 4, 2.56 and 3.1 for management, non-management and user department respondents
According to the manual, it is a best practice to have 95% of machines to have preventive maintenance performed each year.

Table 4.2.20: Summary of preventive maintenance program and hotel strategy

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	Hotel operation allows execution of preventive maintenance.	Strongly agree	2	33.3	2	6.3	4	4.3
		Agree	2	33.3	3	9.4	27	29.0
		Neutral	2	33.3	16	50.0	37	39.8
		Disagree	0	0	7	21.9	17	18.3
		Strongly disagree	0	0	4	12.5	8	8.6
		Total	6	100	32	100	93	100
		Mean	**4**		**2.75**		**3.02**	
		SD	**0.894**		**1.016**		**1**	
2	Everyone understands the link between preventive maintenance and hotel strategy.	Strongly agree	2	33.3	1	3.1	9	9.7
		Agree	0	0	3	9.4	22	23.7
		Neutral	3	50	15	46.9	30	32.3
		Disagree	1	16.7	9	28.1	24	25.8
		Strongly disagree	0	0	4	12.5	8	8.6
		Total	6	100	32	100	93	100
		Mean	**3.5**		**2.63**		**3**	
		SD	**1.225**		**0.942**		**1.113**	
3	The preventive maintenance program is audited timely.	Strongly agree	2	33.3	1	3.1	5	5.4
		Agree	3	50	3	9.3	21	22.6
		Neutral	0	0	13	40.6	36	38.7
		Disagree	1	16.7	12	37.5	25	26.9
		Strongly disagree	0	0	3	9.3	6	6.5
		Total	6	100	32	100	93	100
		Mean	**4**		**2.59**		**2.94**	
		SD	**1.095**		**0.911**		**0.987**	

Source: (Own data, December 2017)

When asked whether they agree or not to the statement "Hotel operation allows execution of preventive maintenance", the engineering management 66.6% accept that the statement is truthful and the rest 33.3% neither agree nor disagree. While the non-management responds only 15% agree 50% neither agree nor disagree and the rest 35% disagree. The respond from the user department is equally divided 33% between agreement, neutrality and disagreement. While the standard deviation almost 1, the mean is 4, 2.5 and 3 for management, non-management and user departments which shows that all departments have diverse idea about the issue.

When asked "Everyone understands the link between preventive maintenance and hotel strategy", almost 50% management and non-management are "neutral". 33% management and user department respondent believe that the statement is a fact while only few (12.5%) non-management agree with the statement.

With regard to the statement "The preventive maintenance program is audited timely", almost 40% non-management and user department respondents are "neutral". From the management respondents 83% confirm that the statement is realistic. But on the contrary almost half (47%) non-management and 1/3 (33%) user department confirm that the statement is unrealistic.

To the same question, the chief engineer responds that the preventive maintenance program is satisfactory. But because of the lack of senior maintenance planner, the audit is not done on time. The mean 4, 2.5 and 3 for management, non-management and user department also shows that there is judgment difference between them.

Table 4.2.21: Summary of understanding of hotel staff towards preventive maintenance

	Question	measurement	Engineering management		Engineering non-management		User departments	
			freq	%	freq	%	freq	%
1	The preventive maintenance program is designed to encourage cooperation.	Strongly agree	2	33.3	1	3.1	8	8.6
		Agree	3	50	8	25.0	24	25.8
		Neutral	0	0	11	34.4	35	37.6
		Disagree	1	16.7	8	25.0	15	16.1
		Strongly disagree	0	0	4	12.5	11	11.8
		Total	6	100	32	100	93	100
		Mean	**4**		**2.81**		**3.03**	
		SD	**1.095**		**1.061**		**1.118**	
2	Performance of preventive maintenance meets accepted standards and reliable.	Strongly agree	2	33.3	2	6.3	8	8.6
		Agree	4	66.7	3	9.4	27	29.0
		Neutral	0	0	15	46.9	34	36.6
		Disagree	0	0	8	25.0	18	19.4
		Strongly disagree	0	0	4	12.5	6	6.5
		Total	6	100	32	100	93	100
		Mean	**4.33**		**2.72**		**3.14**	
		SD	**0.516**		**1.023**		**1.038**	
3	Everyone in the hotel understands that preventive maintenance is responsibility of every person, not just the engineering department.	Strongly agree	1	16.7	1	3.1	12	13
		Agree	1	16.7	4	12.5	31	33
		Neutral	3	50	12	37.5	32	34
		Disagree	1	16.7	8	25.0	10	11
		Strongly disagree	0	0	7	21.9	8	9
		Total	6	100	32	100	93	100
		Mean	**4**		**2.5**		**3.31**	
		SD	**0.894**		**1.078**		**1.103**	

Source: (Own data, December 2017)

As it can be observed on table 4.2.21, point 1, majority (83.3) of management 34% user department and 28% non-management agree to the statement “The preventive maintenance program is designed to encourage cooperation.” Almost equal percentages (35%) of non-management and user department respondents are “neutral”. When one sees the mean 2.8 and 3 for non-management and user department with mean 4 for management, it is clear that while the former categories have same opinion, the later has different one.

When asked “Performance of preventive maintenance meets accepted standards and reliable.” 100% management believes the statement is factual. On the contrary only quarter (25%) non-management and 1/3 (35%) user department respondents believe the statement is factual. The mean 4.33, 2.72 and 3.14 for management, non-management and user department respondents confirms that they have a judgment difference on the topic.

The analysis for the question “Everyone in the hotel understands that preventive maintenance is responsibility of every person, not just the engineering department” shows that, 50%, from the management, 37% from the non-management and 34% user department respondents reply “neutral”. 33% management, 16% non-management and 46% user department respondents believe that the statement is correct. The mean 4, 2.5 and 3.3 for management, non-management and user department respectively shows that there is an opinion difference as usual.

The last interview question that the researcher rose to the chief engineer was “As an experienced chief engineer, what can be done to improve hotel preventive maintenance program?” in his response, first intensive training for technicians, supervisors and maintenance planners as well as operators of the machine must be given and second the computer maintenance management system software should be updated.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Summary of Major Findings

Availability of resources to do the preventive maintenance program

From 15 statements on this subject all engineering management respondents agree whereas minority engineering non-management and user department respondents agree to statements the engineering teams are assigned to do preventive maintenance on their specialized knowledge, all machines on preventive maintenance program have sufficient spare parts, the spare parts used for machines to do preventive maintenance are durable and meet the quality standards, the technicians feel free to order spare parts to perform preventive maintenance and every technician has personal protective equipment and feels safe to do the preventive maintenance program.

In the same topic, for statements the hotel provides training to engineering team so that the preventive maintenance program is effective and the engineering department supervisors provide timely feedback to employees about preventive maintenance performance while engineering management is divided half equally between agreement and neutrality, more than majority engineering non-management and user department respondents disagree with the statements.

Availability of complete machine and equipment inventory

For the statements the inventory system can indicate how many spare parts and consumables are consumed in each machine, the hotel has a master machines and equipment list that needs preventive maintenance, the hotel has grouped machines according to their function, the hotel has a numbering system for every machine for identification and the hotel has spare part inventory periodically which are used for preventive maintenance while almost all engineering management respondents agree, only few engineering non-management and less than half user department respondents agree with the statement.

With the same research question, more half engineering management respondents are neutral for the statements the inventory system is integrated with other preventive maintenance systems, the inventory system is used to calculate preventive maintenance cost the inventory system is capable of identifying spare parts obsolesce there are skilled and experienced personnel that perform machines and spare parts inventory for preventive maintenance program the hotel has periodic machine and equipment inventory update and there is enough spare parts inventory to do preventive maintenance program. To get things worst, when the engineering non-management and user department respondents response for the same statements is reveled, almost all either neutral or disagree with the statements.

Efficiency of computer maintenance management system

For the statements, the hotel has consistently keeps preventive maintenance records in computerized maintenance management system and there is a well-equipped computerized preventive maintenance command center in the hotel while all engineering management respondents agree, very few engineering management and less than half user department respondents agree.

To the statements, the computer maintenance management system gives priority for very important machines preventive maintenance jobs are well planned in advance in the computer system and the system generates report to technicians to evaluate and get feedback their efficiency, majority engineering management respondents agree. In the contrary only few engineering management and user department users agree with the statement.

For the statements, the computer maintenance system is able to detect potential preventive maintenance problems by examining history, the preventive maintenance program is integrated with environment, health and safety program by computer system, technicians and supervisors are familiar with computer maintenance management system, computer maintenance management system is used to order spare parts and consumables for the preventive maintenance program, the computer maintenance system is a major tool to decide machines replacement, the computer maintenance management system records machine down time to measure efficiency, preventive maintenance program efficiency is calculated and given to engineering management

consistently and quality of preventive maintenance planning met the objective by using maintenance management system, half of engineering managements are either neutral or disagree with the statements. When the engineering non-management and user department respondents revealed, almost all non-management and majority of user department respondents are either neutral or disagree with the statement

Implementation of preventive maintenance program and control

All engineering management respondents agree with the statements, the responsibility of every person in the engineering department is clearly defined, all critical machines and equipment have preventive maintenance and performance of preventive maintenance meets accepted standards and reliable. For the same statements only minority engineering non-management and user department respondents agree.

Majority of engineering management respondents believe that the statements preventive maintenance program is designed to encourage cooperation, the preventive maintenance program is audited timely, the engineering department preventive maintenance activities have constant nature and the hotel organizational structure is convenient for implementing preventive maintenance program are true. To the opposite, for the same statements a small number of engineering non-management and user department respondents agree.

For the statements the engineering department teams are dependable in handling preventive maintenance program and everyone understands the link between preventive maintenance and hotel strategy almost half engineering management and non-management respondents are “neutral”.

5.2 conclusions

That preventive maintenance management is a process that allocates and coordinates the resources, including the labor, spare parts and tools to enhance the maintenance performance.

The preventive maintenance problems the study observed is a significant opinion difference between the engineering management in one side and engineering non-management and user department in another side about use of man-power, availability of spare parts and tools to perform the preventive maintenance.

Performing machine and equipment inventory help to develop preventive maintenance instruction, Identify machines with common spare parts and track costs and help determine whether a piece of equipment needs to be replaced.

The result from this study has shown that it is only engineering management believe that the inventory management system to do the preventive maintenance is accurate. Engineering non-management and user departments have the opposite judgment.

The computer system automatically calculates estimated time for preventive maintenance tasks, updating and tracking the average time and cost for completing each task. Plus, with all data stored in one place, one can more effectively manage work orders, purchase orders, inventory, and maintenance records.

The most widespread computer maintenance management system problem are lack of detecting potential preventive maintenance problems by examining history, the system is not a major tool to decide machines replacement, unable to use the system for ordering spares and lack of familiarity of all engineering management and non- management personnel with the system.

Furthermore the result makes clear that while engineering management trust that the hotel structure is convenient for preventive maintenance, there is timely audit and control of the program and the program is consistent in nature, most of engineering non-management and user department disagree.

All departments believe that, the preventive maintenance practice in the hotel is poor in linking the program and hotel strategy.

5.3 Recommendations

On the basis of the findings derived and conclusions drawn with regard to the preventive maintenance management practices of Sheraton Addis hotel, the following recommendations are made with the hope that implementation would alleviate or reduce the problem identified.

✓ The hotel should provide (or use it efficiently if there is one) pervasive channel of regular communication and discussion between management, employees and user department. Moreover it is the engineering management responsibility to disseminate preventive maintenance information to all employees. Without effective communication and discussion it is difficult to create and uphold preventive maintenance practice.

✓ Preventive maintenance training on new machines and equipment is a mandatory factor for longer life of equipment. The hotel must give an attention on this training. The researcher recommends including this training in the purchasing package will result a good output.

✓ Spare parts and materials are much required for preventive maintenance compared to other maintenance strategies. Some parts of facility systems or services need to be replaced with new ones in fixed interval as determined in the maintenance program schedule, whether in cases where the items are damaged or not. Thus, the availability of spare parts is highly concerned in preventive maintenance as it can affect the preventive maintenance performance. The Sheraton Addis engineering management should provide adequate spare part available for preventive maintenance.

✓ The inventory management process begins by having a clear understanding of why one has parts stored on-site. It should be remembered that equipment downtime and parts inventories both cost the company money. The management job is to determine which is cheaper. The Sheraton Addis engineering management should work hard to have the right spare part inventory at the right quantity for preventive maintenance.

✓ It is clear that, computer maintenance management system (CMMS) offers an excellent feature set that delivers the tools necessary for staff members to easily capture and process work while creating the visibility and accountability necessary for proper work force management. The researcher recommends that the computer maintenance management system at Sheraton Addis needs to be upgraded totally.

✓ All hotels should consider preventive maintenance management and come out with specific policies and actions for the maintenance of their facilities, reduction in energy usage and conservation of the use of machines and equipment. It is recommended that future researchers should consider preventive maintenance management in all hotels in Ethiopia due to increasing number of equipment required for operating this industry.

References

Ali, A. S., Kamaruzzaman, S. N., Sulaiman, R., & Au Yong, C. P. (2010). Factors Affecting Housing Maintenance Cost in Malaysia. *Journal of Facilities Management.*

Alsyouf, I. (2007) The role of maintenance in improving companies' productivity and profitability. International Journal of Production Economics.

Bahrami, G. K., Price, J. W. H., & Mathew, J. (1999). The Constant-Interval Replacement Model for Preventive Maintenance: A New Perspective. International Journal of Quality & Reliability Management.

Batun, S., &Azizoğlu, M. (2009).Single Machine Scheduling with Preventive Maintenance International Journal of Production Research.

British Standards Institution. BS 3811: 1984 Glossary of Maintenance Management Terms in Tero technology.

Campbell, J. D. and Reyes-Picknell, J. V. (2006) Uptime: Strategies for Excellence in Maintenance Management (2nd edition). [Electronic] New York: Productivity Press.

Chan, K. T., Lee, R.H.K., Burnett , J.(2003). "Maintenance Practices and Energy Performance of Hotel Buildings", Strategic Planning for Energy and the Environment.

Chan, K.T., Lee, R.H.K., & Burnett, J. (2001). "Maintenance performance: a case study of hospitality engineering systems".

Chandrashekaran, A., &Gopalakrishnan, B. (2008).Maintenance Risk Reduction for Effective Facilities Manangement.

Chareonsuk, C., Nagarur, N., &Tabycanon, M. T. (1997). A Multicriteria Approach to the Selection of Preventive Maintenance Intervals. International Journal of Production Economics.

Chen, D.-H., Lin, D.-F., & Luo, H.-L.(2003). Effectiveness of Preventative Maintenance Treatments Using Fourteen SPS-3 Sites in Texas.Journal of Performance of Constructed Facilities.

Collins English Dictionary, 2003

Derek Miles and Paul Syagga, (1987), Building Maintenance, Intermediate Technology. London

Dictionary of Military and Associated Terms, US Department of Defense, 2005 Flyvbjerg, B. (2004).Five Misunderstandings about Case-Study Research.In Seale.

Espino-Rodr´ıguez, T., Padr´on-Robaina, V. (2005).“A resource-based view of outsourcing and its implications for organizational performance in the hotel sector”.

Eti, M. C., Ogaji, S. O. T., & Probert, S. D. (2006).Development and Implementation of Preventive-Maintenance Practices in Nigerian Industries.

Groote, P. D. (1995). Maintenance Performance Analysis: A Practical Approach. Journal of Quality in Maintenance Engineering.

Hameed, Z., Ahn, S. H., & Cho, Y. M. (2010). Practical Aspects of a Condition Monitoring System for a Wind Turbine with Emphasis on its Design, System Architecture, Testing and Installation. Renewable Energy.

Hassanien, A. (2007) “Exploring the Relationship Between Hotel Renovation and Hotel Inspection,” International Journal of Hospitality and Tourism Administration (IJHTA).

Horner , R . M .W . , El-Haram , M . A .andMunns , A . K .(1997) Building maintenance strategy: A new management approach .Journal of Quality in Maintenance Engineering.

Idrus, A., Khamidi, M. F., & Lateef, O. A. (2009).Value – Based Maintenance Management Model for University Buildings in Malaysia-A Critical Review.Journal of Sustainable Development.

Kangwa, J., & Olubodun, F. (2003). An Investigation into Home Owner Maintenance Awareness, Management and Skill-Knowledge Enhancing Attributes. Structural Survey.

Kelly, Anthony. Plant maintenance management set. Butterworth-Heinemann, 2006.

Lind, H. and Muyingo, H. (2009) Investment theory and why do we need the concept of maintenance, Licentiate Thesis in Buildings and Real Estate Economics, Stockholm.

Mann, L., Saxena, A., & Knapp, G. M. (1995).Statistical-Based or Condition-Based Preventive MaintenanceJournal of Quality in Maintenance Engineering.

Marquez, A. C., De Leon, P. M., Fernandez, J. F. G., Marquez, C. P., & Lopez, C. M. (2009). The Maintenance Management Framework: A Practical View to Maintenance Management. Journal of Quality in Maintenance Engineering.

Moghaddam, K. S., & Usher, J. S. (2010).Optimal Preventive Maintenance and Replacement Schedules with Variable Improvement Factor.Journal of Quality in Maintenance Engineering.

Moubray, J. (2003), “Twenty-first Century Maintenance Organization: Part I – the Asset

Management Model", Barrington, IL: Maintenance Technology, Applied Technology

Mugenda, M., & Mugenda, G. (2003).*Research Methods:* Quantitative and Qualitative Approaches. Nairobi: Acts Press

Pandey, D., Kulkarni, M. S., &Vrat, P. (2010).A Model for Optimal Maintenance Interval Incorporating the Cost of Rejections in Manufacturing.Journal of Advances in Management Research.

Parida, A., & Kumar, U. (2006). Maintenance Performance Measurement (MPM): Issues and Challenges. Journal of Quality in Maintenance Engineering.

Peter Makomere (2014) Effects of preventive maintenance of asset on quality of production and service delivery in selected hotels in Kenya. University of Eldort Kenya

Rao, S. S. (1992). Reliability-Based Design. New York: McGraw-Hill.

Seeley, I.H. (1993) Building Maintenance, Macmillan Press Limited.

Sheraton maintenance management system manual (2013).

Susan Aryee (2011) Hotel maintenance management, Department of real estate and construction management, Stockholm Sweden

Swanson L. (2001) Linking maintenance strategies to performance.

Tsang, A. H. C. (1995). Condition-Based Maintenance: Tools and Decision Making Journal of Quality in Maintenance Engineering.

Waeyenbergh, G. and Pintelon, L. (2002) A framework for maintenance concept development.International Journal of Production Economics.

White, D.J .(1975) Decision Methodology John Wiley & Sons, London.

Yang, S. K. (2004).A Condition-Based Preventive Maintenance Arrangement for Thermal Power Plants.Electric Power Systems Research.

Zuashkiani, A., Rahmandad, H., & Jardine, A. K. S. (2011).Mapping the Dynamics of Overall Equipment Effectiveness to Enhance Asset Management Practices.Journal of Quality in Maintenance Engineering.

Appendix 1: Questionnaire

Dear participants,

I would to request your help. I am a member of engineering department and graduate student of Saint Mary's university. I am conducting a survey on Preventive maintenance practices in our hotel for my master (MBA) thesis.

The survey should only take 30 minutes of your time. Your answers are unanimous; DO NOT write your name on the survey. Only group results will be documented, not individual answers. Your help with this survey is strictly voluntary.

I thank you in advance for your honest answer for the questions.

Sincerely yours,

Theodros Getachew

Engineering department

Personal information

1. Gender

Male ☐ Female ☐

2. Age

18-24 ☐ 25-29 ☐ 30-34 ☐ 35-39 ☐

40-44 ☐ 45-49 ☐ 50-54 ☐ 55 and over ☐

3. Department

Engineering ☐ Food preparation ☐

Stewarding ☐ Housekeeping ☐

4. Education

High school complete ☐ Diploma ☐

Degree ☐ Masters ☐

5. Work experience in Sheraton Addis

0-5 Years 6-10 ☐ars ☐

11-15 Years ☐ 16-20 Years ☐

6. Position

Non- management ☐

Management ☐

Resources availability to do the preventive maintenance

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
		1	2	3	4	5
1	The engineering department technicians have the necessary special tools to do the preventive maintenance program.	☐	☐	☐	☐	☐
2	The engineering department is well staffed in terms of education and experience.	☐	☐	☐	☐	☐
3	All Machines which has Preventive maintenance have instructions and procedures to do the preventive maintenance program.	☐	☐	☐	☐	☐
4	The hotel provides training to engineering team so that the preventive maintenance program is effective.	☐	☐	☐	☐	☐
5	All machines on preventive maintenance program have sufficient spare parts.	☐	☐	☐	☐	☐
6	The spare parts used for machines to do preventive maintenance are durable and meet the quality standards.	☐	☐	☐	☐	☐
7	The engineering teams are assigned to do preventive maintenance on their specialized knowledge.	☐	☐	☐	☐	☐
8	The engineering department skilled labor is satisfactory in terms of quantity (number) to accomplish preventive maintenance program.	☐	☐	☐	☐	☐
9	The engineering department supervisors provide timely feedback to employees about preventive maintenance performance.	☐	☐	☐	☐	☐
10	The hotel has dedicated and skilled preventive maintenance planner.	☐	☐	☐	☐	☐
11	There is enough available time to do preventive maintenance program.	☐	☐	☐	☐	☐
12	Every technician has personal protective equipment and feel safe to do the preventive maintenance program.	☐	☐	☐	☐	☐
13	The technicians feel free to order spare parts to perform preventive maintenance.	☐	☐	☐	☐	☐
14	Every technician is involved in the preventive maintenance planning and preparation.	☐	☐	☐	☐	☐
15	The preventive maintenance instruction has safety procedure before starting a task.	☐	☐	☐	☐	☐

Machines and spare parts Inventory to do preventive maintenance						
		Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
		1	**2**	**3**	**4**	**5**
16	The hotel is using computerized inventory system.	☐	☐	☐	☐	☐
17	The hotel has a numbering system for every machine for identification.	☐	☐	☐	☐	☐
18	The hotel has a master machines and equipment list that needs preventive maintenance.	☐	☐	☐	☐	☐
19	The hotel has periodic machine and equipment inventory update.	☐	☐	☐	☐	☐
20	The hotel has grouped machines according to their function (e.g.. Power generation and distribution, water treatment, pumps, fire and safety…etc.)	☐	☐	☐	☐	☐
21	The preventive maintenance documents and manuals are updated whenever there are machines and equipment are bought and replaced.	☐	☐	☐	☐	☐
22	All spare parts inventory for preventive maintenance are accountable for price.	☐	☐	☐	☐	☐
23	The hotel has spare part inventory periodically which are used for preventive maintenance.	☐	☐	☐	☐	☐
24	The hotel has a system to avoid machines which are obsolete or out of operation.	☐	☐	☐	☐	☐
25	There is enough spare parts inventory to do preventive maintenance program.	☐	☐	☐	☐	☐
26	The inventory system is used to calculate preventive maintenance cost	☐	☐	☐	☐	☐
27	The inventory system is integrated with other preventive maintenance systems.	☐	☐	☐	☐	☐
28	There are skilled and experienced personnel that perform machines and spare parts inventory for preventive maintenance program.	☐	☐	☐	☐	☐
29	The inventory system is capable of identifying spare parts obsolesce (No more available).	☐	☐	☐	☐	☐
30	The inventory system can indicate how many spare parts and consumables are consumed in each machine	☐	☐	☐	☐	☐

Computer maintenance management system						
		Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
		1	**2**	**3**	**4**	**5**
31	Computerized work order system is in place to allow effective management of preventive maintenance work.	☐	☐	☐	☐	☐
32	The hotel has consistently keeps preventive maintenance records in computerized maintenance management system	☐	☐	☐	☐	☐
33	There is a well-equipped computerized preventive maintenance command center in the hotel.	☐	☐	☐	☐	☐
34	Soft copy of documents and manuals are readily available in the computer system for preventive maintenance activities.	☐	☐	☐	☐	☐
35	The computer maintenance management system records machine down time to measure efficiency.	☐	☐	☐	☐	☐
36	Quality of preventive maintenance planning met the objective by using maintenance management system.	☐	☐	☐	☐	☐
37	Preventive maintenance jobs are well planned in advance in the computer system.	☐	☐	☐	☐	☐
38	Preventive maintenance program efficiency is calculated and given to engineering management consistently.	☐	☐	☐	☐	☐
39	The computer maintenance management system gives priority for very important machines.	☐	☐	☐	☐	☐
40	The preventive maintenance program is integrated with environment, health and safety program by computer system.	☐	☐	☐	☐	☐
41	Technicians and supervisors are familiar with computer maintenance management system.	☐	☐	☐	☐	☐
42	The system generates report to technicians to evaluate and get feedback their efficiency.	☐	☐	☐	☐	☐
43	The computer maintenance system is able to detect potential preventive maintenance problems by examining history.	☐	☐	☐	☐	☐
44	The computer maintenance system is a major tool to decide machines replacement.	☐	☐	☐	☐	☐
45	Computer maintenance management system is used to order spare parts and consumables for the preventive maintenance program.	☐	☐	☐	☐	☐

Preventive maintenance practice at Sheraton Addis						
		Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
		1	**2**	**3**	**4**	**5**
46	The hotel management is committed for preventive maintenance execution.	☐	☐	☐	☐	☐
47	All critical machines and equipment have preventive maintenance.	☐	☐	☐	☐	☐
48	The engineering department preventive maintenance activities have constant nature.	☐	☐	☐	☐	☐
49	The overall structure of the engineering department is logical to accomplish preventive maintenance program.	☐	☐	☐	☐	☐
50	Hotel operation allows execution of preventive maintenance.	☐	☐	☐	☐	☐
51	Everyone in the hotel understands that preventive maintenance is responsibility of every person, not just the engineering department.	☐	☐	☐	☐	☐
52	Performance of preventive maintenance meets accepted standards and reliable.	☐	☐	☐	☐	☐
53	The hotel sets priorities for preventive maintenance activities.	☐	☐	☐	☐	☐
54	The responsibility of every person in the engineering department is clearly defined.	☐	☐	☐	☐	☐
55	The engineering department teams are dependable in handling preventive maintenance program.	☐	☐	☐	☐	☐
56	The hotel uses comprehensive written preventive maintenance strategy that guides planning for maintenance management.	☐	☐	☐	☐	☐
57	The hotel organizational structure is convenient for implementing preventive maintenance program.	☐	☐	☐	☐	☐
58	Everyone understands the link between preventive maintenance and hotel strategy.	☐	☐	☐	☐	☐
59	The preventive maintenance program is audited timely.	☐	☐	☐	☐	☐
60	The preventive maintenance program is designed to encourage cooperation.	☐	☐	☐	☐	☐

Appendix 2: Interview guide

Interview questions for the chief engineer

1. To what extent does tools, spare parts, manuals, drawings and instructions are readily available for the preventive maintenance program?
2. How often do you train staff in relation to preventive maintenance? Do you give certificates to those who undergo training?
3. In your opinion, is engineering department man power is satisfactory in terms of quantity (number) and quality (education and Experience) to accomplish preventive maintenance program?
4. Do the preventive maintenance documents and manuals are updated whenever there are machines are bought and replaced. Are they stored where everybody can get access?
5. Does the inventory system:
   A. Has a master machines and equipment list that needs preventive maintenance with numbering system for each machines?

B. Sort out spare part for preventive maintenance from other spares? Is it accurate?

C. Specify how many spare parts are consumed for each machine?

6. Does the computer maintenance management system (CMMS):
   A. Records machine down time to measure efficiency?

B. Able to detect potential preventive maintenance problems by examining history?

C. A major tool to decide machines replacement?

7. Quality of preventive maintenance program met the objective? Is the efficiency calculated timely and given to management?

8. How will you rate the Preventive maintenance program? Do you have quality control (Audit) on your Preventive maintenance program?

9. As an experienced maintenance manager what can be done to improve hotel preventive maintenance program?

Declaration

I, Theodros Getachew, declare that this thesis is my original work, prepared under the guidance of assistant professor Simon Tareke. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

_____ _____

Name Signature

St Mary's university college, Addis Ababa **December, 2017**

Endorsement

This thesis has been submitted to St Mary's university college, school of graduate studies for examination with my approval as a university advisor.

_____ _____

Advisor Signature

St Mary's university college, Addis Ababa **December, 2017**