SPARE PARTS OPTIMIZATION (VALVE) FOR BOILER AT COAL FIRED POWER PLANT

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This report is submitted
In fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "Spare Parts Optimization (Valve) For Boiler At Coal Fired Power Plant" is the result of my own work except as cited in the references

Signature : .....

Name : Akmal Abdul Rahim Ahmad

Date : 23/5/2017

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Plant and Maintenance with Honor).

Signature :. .....

Name of Supervisor : Dr. Reduan Mat Dan

Date : 23/5/2017

DEDICATION

To my beloved parents En. Ahmad Yaakob, Pn Ummi Kelsom Fei@Ghazali, all TNBJ's staff, supervisor Dr. Reduan Mat Dan and friends who are always encourage and support me while completing this project.

ABSTRACT

Spare part is one of the common precaution used by a company to ensure the availability of their machine in an optimum level. By optimizing the spares inventory, the power plant company can reach the optimum level of availability and indirectly will increase the reliability of the plant. Any lack of spares can lead to company losses in form of maintenance cost, operation loss and material loss. In addition, the lack of spare also can increase the mean time to repair and lead to the production stoppages. However, if the number of spares are more than the requirement, company will bear some losses as the spares will not be in used and may lead to the obsolete items. Besides that, if the spare was protected by an insurance and being kept in the inventory, it may lead to the waste of money and inventory space that can be used in another purpose such as preventive and predictive maintenance. Thus, the company needs to analyse the failure and the stock movement to optimize the spare and increase the reliability of the plant. There are some analysis that can be used to optimize the number of the spare such as Pareto analysis, Failure Trend analysis and Movement analysis. To conduct this analysis, engineer and technician must be aware and monitor the movement of the spare to get a significant data that can be used in the analysis. Therefore, the analysis can be more accurate and the optimised list of spare can be issued by the company. All the steps to optimizing spares was covered in this paper.

Keywords: power plant; spare parts; inventory; Pareto analysis; Failure trend analysis; Movement analysis, cost; optimize.

ABSTRAK

Alat ganti adalah salah satu langkah berjaga-jaga yang biasa digunakan oleh syarikat untuk memastikan adanya mesin mereka di tahap yang optimum. Dengan mengoptimumkan inventori alat ganti, syarikat loji kuasa boleh mencapai tahap optimum ketersediaan dan secara tidak langsung akan meningkatkan kebolehpercayaan kilang. Sebarang kekurangan alat ganti boleh menyebabkan kerugian syarikat dalam bentuk kos penyelenggaraan, kerugian operasi dan kerugian bahan. Di samping itu, ketiadaan alat juga boleh meningkatkan purata masa untuk membaiki dan membawa kepada kadar pengeluaran terhenti jika kegagalan tersebut berpunca daripada mesin kritikal. Walau bagaimanapun, jika jumlah alat ganti lebih daripada arahan kerja, syarikat akan menanggung beberapa kerugian sebagai contoh alat ganti tidak akan di digunakan dan boleh menyebabkan alat ganti tersebut usang. Selain itu, jika alat ganti ini dilindungi oleh insurans dan disimpan dalam inventori, ia boleh membawa kepada pembaziran wang dan ruang inventori yang boleh digunakan untuk kegunanan yang lain seperti penyelenggaraan pencegahan dan ramalan. Oleh itu, syarikat perlu menganalisis kegagalan dan pergerakan untuk mengoptimumkan bilangan alat ganti dan meningkatkan kebolehpercayaan kilang. Terdapat beberapa analisis yang boleh digunakan untuk mengoptimumkan bilangan bahagian seperti analisis Pareto, analisis Gaya Kegagalan dan analisis Gerakan. Untuk menjalankan analisis ini, jurutera dan juruteknik perlu menjaga dan memantau pergerakan alat ganti untuk mendapatkan data penting yang boleh digunakan dalam analisis. Oleh itu, analisis akan menjadi lebih tepat dan senarai alat ganti yang telah dioptimumkan boleh dikeluarkan oleh syarikat. Semua langkah-langkah untuk mengoptimumkan alat ganti telah dibincangkan dalam kertas ini.

Kata kunci: loji kuasa; alat ganti; inventori; analisis Pareto; analisis Gaya kegagalan; analisis Pergerakan, kos; mengoptimumkan.

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I would like to express my deepest appreciation to my supervisor Dr. Reduan Mat Dan for giving me this opportunity to do final year project with him. He never hesitated to give me advice and guidance whenever I confronted problems. I am thankful for his patience and advice while leading me in this project.

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CONTENT

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LIST OF ABBREVIATIONS

MTTR	Mean Time To Repair
MTBF	Mean Time Between Failure
MTTF	Mean Time To Failure
GF1	Generate Facilities 1
OEM	Original Equipment Manufacturer
RAM	Reliability, Maintainability, and Availability
CBM	Condition Based Monitoring

CHAPTER 1

INTRODUCTION

1.1 Background

It is now well recognized that an efficient maintenance system will decrease the cost for maintenance in a company or organization. To decrease the downtime of a maintenance, the company must define all the uncontrolled and controlled variables in the power plant. Besides that, there are some methods that researcher can do to reduce the maintenance cost in the power plant. Firstly, minimize bottlenecks within the integrated plant. When the congestion to do the maintenance activity in the plant decrease, the mean time to repair (MTTR) will decrease. Consequently, the cost for maintenance activity will decrease.

A systematic system can also decrease the cost for maintenance. As example, generate shift on some works or process it will makes the flow of production move smoothly and decrease the time for performing the activity especially maintenance activity. Besides that, by regulating the predictive maintenance and the relation with the management can increase the overall equipment availability. This is because, by performing a predictive maintenance correctly, researcher can estimate the time for machine to fail and the parts that need to repair or replace. This indirectly will save the cost for spare parts and decrease the MTTR in the plant.

Alteration of the plant operations especially on critical facilities in the plant such as pump, valve and compressor will increase the performance on the current production systems. This can be related with the availability of the machine. When a machine is available for the production, the loss of the plant can be decreased. By optimizing the spares, indirectly will increase the reliability and availability of the machine to the plant. Furthermore, if the spares required to repair a failed machine are ready, the time for the machine to operate normally will decrease.

By optimizing the spare, the company also can eliminate unnecessary spares that do not produce any benefit to the plant. The cost for store and insurance also can be reduced. In addition, a systematic spares management also can be produced as the spares are optimized. The maximum number of spares also can be determined by analyzing the usage of the spares in the past year. By observing the trend of the spares usage, a set of quantitative data can be obtain. This data can be used as a medium to calculated the effectiveness of the spare parts between present management and the propose solution.

Additionally, by dividing the spares into several types and perform some analysis such as Pareto Analysis and Movement Analysis, the reliability of a plant can be improved. Furthermore, company can estimate how fast the spares have been used. Consequently, company can decrease the loss and the estimated number of spare can be optimized. As a simple conclusion, optimize the spares inventory will affect the company expenditure by decreasing the lost in maintainability and productivity in the plant.

1.2 Problem Statement

The power plant company indicates some loses when there was a failure occur on the machines at the plant. The production of the plant will be stopped if any of critical machinery failed and this will affect the company profit. The company found some factors that may affect the failure such as high pressure and temperature during the operation, lack of preventive and predictive maintenance in the plant and lack of maintenance awareness at the plant. The plant perform the predictive maintenance as a method to decrease the failure. However, the excessive time required to repair the machine come to be a major problem that cause the production to stop longer than what have been expected by the company. There are many factors that influent the problem. By observing the problem, the maintenance department found that the main cause of the excessive time for repair was lack of spares. This is because most of the parts on the critical machine is very expensive and some of the parts must be imported from oversea. The lack of spares at critical time will make the company to spend a lot of money on it. Besides that, some of the spares in the

inventory is not moving at all by years and it reduce the space in the inventory. This is very costly as the old spares have their own expired date that require it to be disposed and most of the critical expensive spares need insurance that must be paid by the company monthly. By concluding the problems, the maintenance department agreed that the spare parts management need to be more effective by lowering the loss that cause by the spare. By optimizing the spare management, the loss of the company can be reduced and the times for repair the machine are also can be decrease.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To reduce the loss of company by optimizing the spare parts management in the plant.
2. To increase the reliability and availability of the machine in the plant

1.4 Scope of Project

The scopes of this project are:

1. The results are only from GF1 facilities at power plant are presented in this report. The previous results of the maintenance cost are obtained from another set of measurement conducted by the contractors, technicians and engineers in the power plant.
2. The data obtained for education purpose only due to confidential data and limited access to the whole power plant.

1.5 EXPECTED RESULT

The expected result of this project are:

1. Maintenance cost can be decreased due to spares optimization.
2. A systematic maintenance system can be performed.
3. Time taken for maintenance activity can be decreased.
4. The company profit increased.

1.6 GENERAL METHODOLOGY

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review

   Journals, articles, or any materials regarding the project will be reviewed.

2. Field work

   Inspection

   - The plant layout in the power plant will be inspected and the occupants will be interviewed to identify the cost of maintenance at the power plant.

   Measurement

   - The measurement will be conducted at the area Generate Facilities 1 (GF1) at the power plant. Another measurement will be taken directly from engineer at the power plant. Measurement data from contractors work on the maintenance activity before will also be collected for comparison.

   Calculation

   - Calculation of the maintenance cost such as MTTR will be made based on the data input from the measurement.

   Analysis and proposed solution

   - Analysis will be presented on how we can reduce the maintenance cost and also the root cause of the problem. Solutions will be proposed based on the analysis.

3. Report writing
   - A report will be written at the end of the project on this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Optimizing Spare Part

There are two main part to optimize the level of spare parts which are cost and the effectiveness of spare parts. By holding absolute minimum number of spare which is necessary to meet the needs, indirectly will decrease the cost of spare part. However, minimizing the number of spare parts is not the only things that must be considered. This is because, the availability of the spare parts when it is required is also an importance measures of decreasing the time of maintenance activity or in other words it called as effectiveness of spare parts.

Furthermore, planner should be aware of the spares strategy that can be used to optimize the number of spare parts in a plant. By knowing the number of spare needed for the preventive maintenance activity which is already a routine for the maintainer, they should know the pattern and can predict the requirement for spares. This will increase the effectiveness of the spare parts. For corrective maintenance, there must be a pattern of it for the past year and this pattern can be a benchmark to estimate the number of spares.

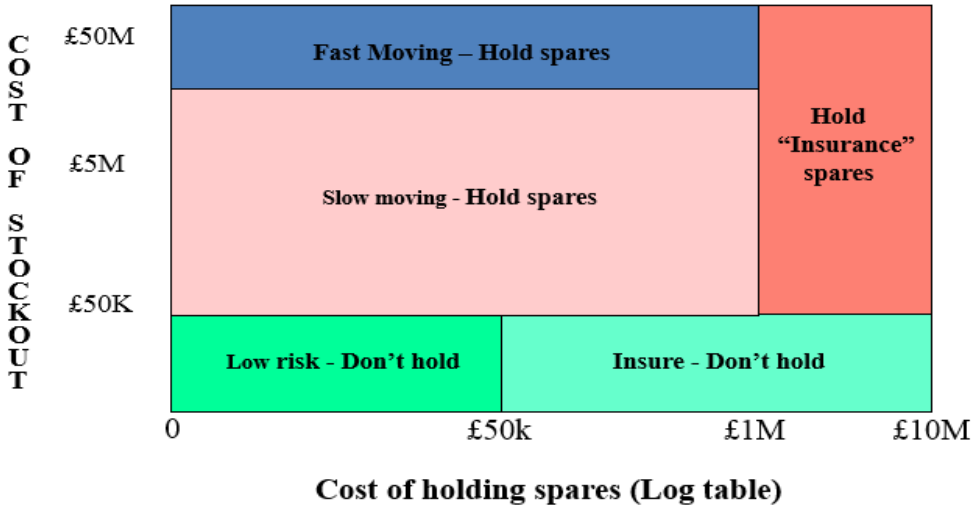

Figure 2.1.1: Example of spare management strategy (Paul Wheelhouse, 2012)

In addition, planner must be aware to the spare policy by considering all types of spare and how fast the spare is moving. There are several types of spare that must be categorized to ensure their need. Increase efficiency of the plant requirement will minimize the machine downtime and availability in the plant. A good spare policy also will minimizing the MTTR by installing the suitable part in a short time. Furthermore, a good spare management can also decrease the cost for part holding which is one of critical problem on spare management.

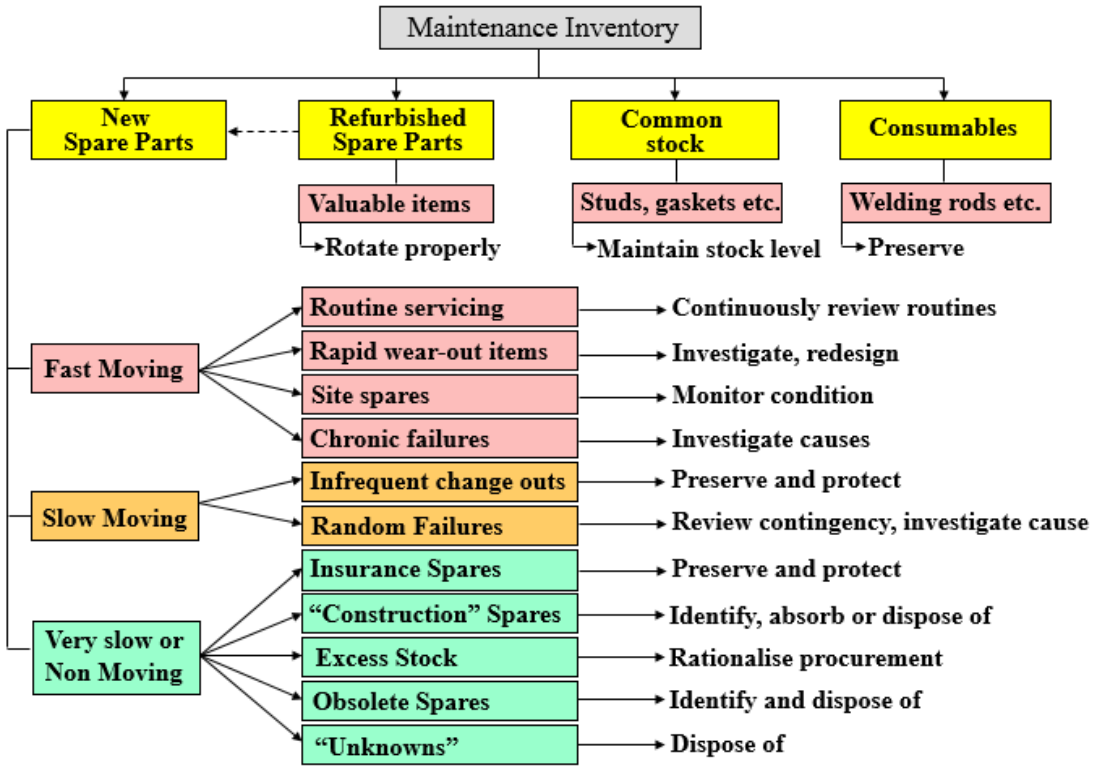

Figure 2.1.2: Type and policy of spares (Paul wheelhouse, 2012)

Spares management requires many topic to be covered such as the need of the spares, lead-time, factors that will affect spare holding and the strategies to reduce the inventory. The need of the spares is importance because 1/3 to 1/2 of the maintenance expenditure is only on spare parts inventory. Additionally, maintenance without necessary parts will increase the loss of a company (Paul Wheelhouse, 2012). All this topic must be covered to ensure that the plant meet all the requirement for optimizing their spare parts.

2.2 Spare Parts Inventory for New Spares

New spare part is a substitutable part that kept in the inventory and will be used for replacement to the failed unit, UK White Goods (2016). By decreasing the Mean Time to Repair (MTTR), indirectly will decrease the cost for maintenance activity. There are three types of new spare part which are fast moving, slow moving and very slow or non-moving spare parts.

Fast moving spare part is spare that need a less time to be stored in the inventory. This spares are usually selected by analysis on the routine serving done by the company. Analysing the rapid wear-out items and the common failure on a machine will indicate the time and the estimation number for failure. This indirectly will come out with a set of spare required in certain time. Therefore, the spare selected will be moving fast and take a short time to be replaced.

Slow moving spare can be consumed as spare that need a longer time in the inventory as the necessity for replacement is lower than fast moving spare. This types of spare usually for preserve and protect the production rate as the part is rarely to be fail. Furthermore, this spare also be ready for a random failure that may be happen on the machine. This will lower the time for the machine to operate again or in the other words, the availability of the machine to the production rate can be increased.

The final one is very slow or non-moving type of spare part. This usually the most valuable spares in the inventory. This is because most of the part was covered by the insurance as the company needs to make sure that the part is still usable and protected for a long time. Many people are targeting the slow moving inventory as a silver bullet for the spare part optimization. Usually, this is based on the belief that being a slow moving spares prove they are not really needed. This is mistaken because the spares could be needed sometimes but infrequently, Phillip Slater (2016). Additionally, the slow moving spares may for the critical machinery that needs to use on time or else the production will stop. Therefore, before the failure occur, the best things to do is make a spare so that the availability of the machine can be increase.

2.3 Spare Parts Inventory for Repairable Items

Spare parts inventory of a power plant typically accounts for more than 5% of the operating cost. An excess of spare parts will leads to a high holding cost and it slow down the cash flows, whereas insufficient spare parts result in costly production delays and causing a negative impact on the plant performance. Different companies will need a different type and number of spare parts. Spare parts inventories are different from other types of inventories in companies, Cohen et al (1990). Rego et al (2006) have pointed out several important factors on the spare management for the inventories:

- Customers have increasing expectations and the concerning of quality associated with the services and products. The rate of failure is already a concern and the delay in repairing due to lack of spare parts will degrade the clients' negative perception;
- Some of the items have a high demand such as parts with great wearing and related to the preventive maintenance, but the great majority has irregularly demand.
- The increasing complexity of products and the life cycles saving will generate an increase on an amount of active codes and risk of undesirability.

Repairable items are components or assets that after a failure occur,they will be submitted to a repair cycle to be used again as a substitute of been discarded, Fritzsche et al (2016). It suggests that a repairable item spare parts inventory system must have a repair shop where failed components are repaired, as well as a warehouse where spare parts are stocked (Perlman and Levner, 2010).

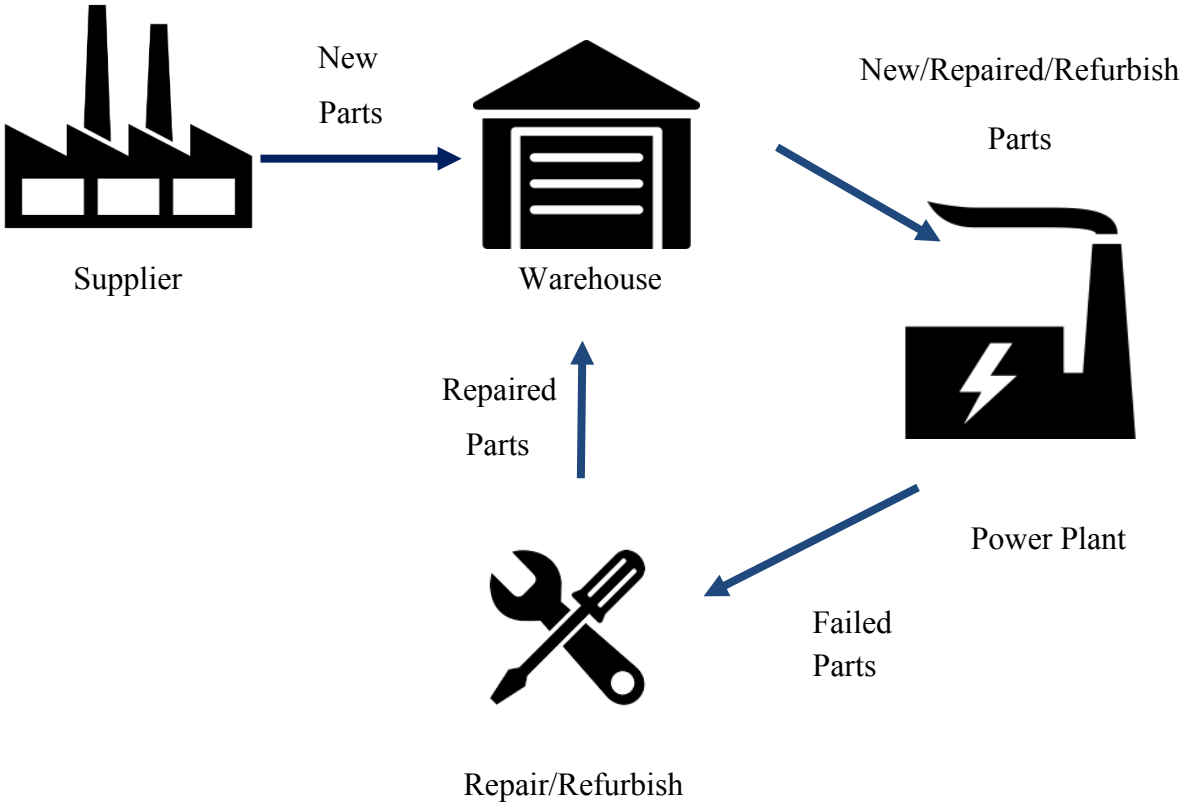

Figure 2.3: spare parts inventory for repairable items

Based on the **Figure 2.3** above, it is considered that spare parts are usually bought from the same supplier and delivered to the warehouse. When a component installed on the plant's equipment fails, it is removed and sent for repair or refurbish shop to be repaired. The fault component will be replaced by the new one from the warehouse. If there is no spare part for critical machine in the warehouse, thus production of the power plant will stop until a new part is provided.

When the repairable component fault, it will arrive in the repair shop for the repair process. There are also parts in the plant which can be refurbished such as journal bearing. This process also can decrease the cost for buying a new part. When the repair process ends, it will be sent back to the warehouse and standby for replacement if the failure occur. The repair process can be considered to be perfect if the repaired components returns as good as a new condition. But if imperfect process have been applied, the repaired components will keep a residual degradation. Imperfect repair models were presented by Do Van at al (2012) and Doyen et al (2004). In this paper, consider that the repair place has an infinite capacity because usually this company will pass it to the contractors and no degradation occurs.

2.4 Spare Parts Inventory for Common and Consumable Items

Paul wheelhouse stated that there are four types of spare parts which are new, refurbish, common and consumable. The common and consumable spare are classified in different type. Researcher disagree with that statement because they should in the same class which is consumable. Consumable is part or material used by an individual or a company that must be replaced recurrently because they will wear out or finished, Y.Ming et al (2013). They also can be defined as the spares of end product that have been used up or permanently reformed in the process of manufacturing and repairing, G.Ojeih (2016) .

As what have been mentioned by Paul, the example of common spares are screws and the consumable spares are welding electrodes. Researcher state that all of the example are defined as consumable as the company used it until wear out or finish. Both of this types also must be replaced regularly as it have been commonly used in the plant. There are two type of consumable spares. First is durable spares which can be store in a time while the other type is nondurable spares which only can be store in a short time. Furthermore, the example of non-durable spare is ricin that used for water treatment which have their expired but if it been used, so it consider as must be replace.

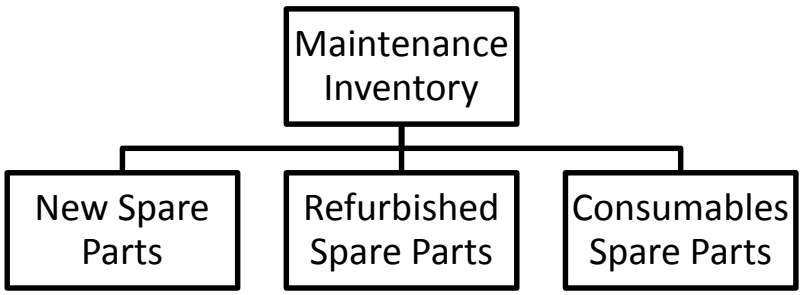

Figure 2.4: Spare parts classification

Researcher believed that the two types of spare must be classified together as they will be used commonly and will be replaced regularly. Therefore **Figure 2.4** is the new spare parts classification.

2.5 Inventory Management

A good spares management will increase the company reliability by decreasing the repair time. To manage a good inventory storage, first look deeply on the need. By doing some research and monitor the repair part time by time, will altered up the result and get more accurate data. Observe the holding inventory, is the stored spares have benefit to the availability or only a waste. Eliminating the unnecessary part will increase the effectiveness and reliability of a plant, Mladen et al (2010)

Lead time is an important things that must be reviewed. This is because all of the spares have a sequence to be followed before it can be stored. Furthermore, if the spare is imported from the other country, the lead time will increase and lead to further delay from receiving the spare. There are several element of lead time that must be facing by company before they proceed to storing part as illustrated in **Figure 2.5**. By minimize the lead time with a proper management the availability and reliability of the spare can be increase.

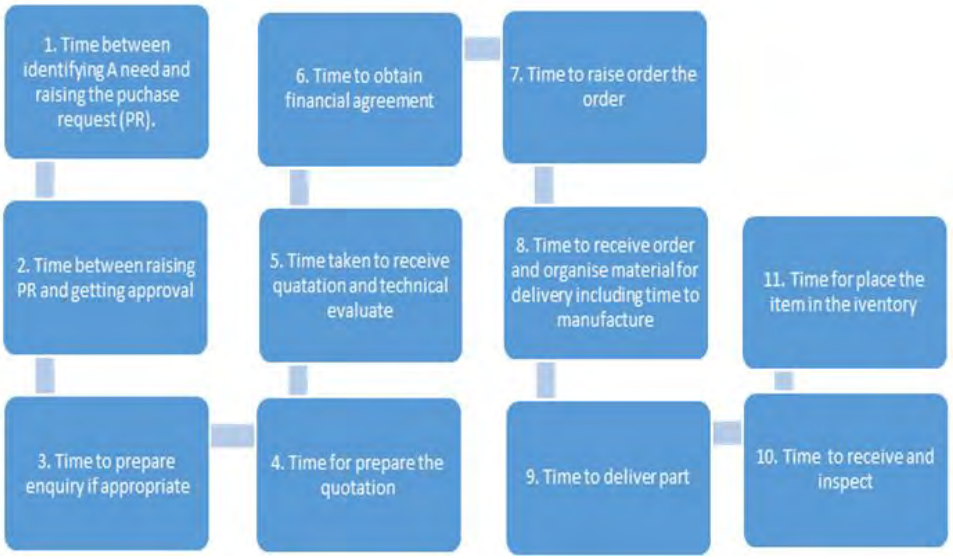

Figure 2.5: Lead time elements