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Exploring Overall Equipment Efficiency Model of Laboratory Capital Equipments in Malaysian Public Universities

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Abstract

Overall Equipment Effectiveness (OEE) began to be recognized as a fundamental method for measuring plant performance in the late 1980s and early 1990s. It was a period that saw the emergence of serious big company maintenance benchmarking, the introduction of Total Productive Maintenance (TPM) in United State of America and the founding of the Society for Maintenance Reliability Professionals. At first, *OEE* was closely bound to TPM and often was seen as a defining measurement for winning the TPM Prize. Recognizing *OEE* as an effective productivity management metric is one thing, using it effectively is another, as many practitioners have found out. In this research, accurately survived to develop a practical how to approach to using *OEE* which lays out in *Overall Equipment Effectiveness* to Overall Equipment Efficiency (OEE) whereas participating of quality performance and organizational management elements could be involved in creating an integration measurement model of OEE for identify the performance efficiency of the high capital equipment purchased in public universities in Malaysia. The methodologies of this research will be proposed to conducting interviews with the experienced respondents among department head, instructor, lecturer and technicians in public universities, searching the related topic literatures, white papers, technical papers, conference proceedings, web pages or even communicate to the personnel in selected public universities in Malaysia. The potential research finding is to develop a new OEE measurement model of laboratory capital equipment in public universities towards proper managing the technology of capital equipment consist utilization, performance and quality management.

Keywords

Overall Equipment Efficiency, quality performance, organizational performance, performance efficiency, quality management

1.0 An introduction of this study

This study is the beginning of all my studies at the post graduate to accomplish the study necessities, essentially to look the utilization of overall equipments purchased in public universities in Malaysia. As we know, the government spent a huge of capital to purchase high-tech equipments to facilitate the teaching and research equipment intended for both of undergraduate and post-graduate students. From the use of capital equipments in any engineering lab at public universities in Malaysia, not all capital equipment used in full accordance with the accepted schedule of learning. But the purchase of capital equipment must be led in terms of actual needs in the use of such equipment by the university. Therefore, a study should be conducted, particularly in determining the purchase of equipments to examine the factors of OEE's before the purchase decision is determined. If the percentage of low OEE's below the 85% then a decision must be taken to avoid wastage of expenditure. In this study, among others will find the basis of justification why the need for this study include determining the validity of the availability, performance and quality efficiency. Factor in the OEE is usually practiced in the manufacturing industry, but researchers trying to spearhead its applications in the manufacturing industry sector is not the institution of higher education, particularly in the purchase of capital equipment to determine factors that actually have a high potential and beneficial to all parties. Factors such as availability and performance efficiency can be applied at the public universities but the quality factor of efficiency will be determined based on the measurement of human ability itself.

2.0 Definition of Capital Equipment

- 2.1 Capital Equipment means machinery and equipment purchased or leased and used by the purchaser or lessee primarily for manufacturing, fabricating, mining or refining tangible personal property to be sold ultimately at retail and for electronically transmitting results retrieved by customer of an online computerized data retrieval system (Thomas R. Muck, Minnesota Supreme Court in Minnesota, 2004).
- 2.2 Capital Equipment defined is equipment for which university holds title which is non-expendable, tangible, personal property acquired for USD 5,000 or more and which has a normal life expectancy of more than one year. The capital value of university inventorial equipment is the same as its acquisition value (Management and Control of University Equipment, University of California, 2007).
- 2.3 Capital Equipment is defined as any individual item costing \$5,000 or more and having a useful life of at least one year. A component part can be defined as any item which cannot stand alone and is considered an integral part and an enhancement to an existing piece of equipment. Component parts costing less than \$5,000 should not be capitalized, unless the component is considered part of a fabrication of capital equipment. Component parts costing \$5,000 or more should be capitalized provided the item has a useful life of one or more years (University Titled Property, Business Services of Wisconsin University, 2005).

3.0 Additional significance of this study

The importance of maintenance

Maintenance can be defined as all activities necessary to keep a system and all of its components in working order. The objectives of any maintenance program should be to maintain the capability of the system while controlling the cost. The components of the cost can be further defined as follows:

- The cost of maintenance labor and material.
- The cost of production loss due to an inadequate and ineffective maintenance program.

(Matthew P. Stephens, 2004)

Effective maintenance is a crucial component in any organizations operating strategy. This is because it sustains the organizations reputation in the eyes of its current and potential customers, its owners and the general public. Maintenance strategy is about the avoidance of both tangible and intangible losses. As a consequence, an organization must first decide its business and supply-chain strategies and from these develop its strategic targets for proper maintenance (Mike Briggs and Chris Atkinson, 2000).

The effectiveness of a maintenance concept relates to the results achieved in terms of reliability and availability. The efficiency of a maintenance concept concerns the resources used, i.e. costs of equipments, material, spares, man power, etc. This efficiency can be seen as the sum of elementary efficiency is the decrease in failure cost due to the

maintenance plan and the combinatorial efficiency is the decrease in cost due to doing different maintenance tasks simultaneously. Neither elementary efficiency, nor combinatorial efficiency can guarantee that the desired equipment effectiveness is achieved. Therefore, optimum maintenance concepts are expressing the best trade-off between efficiency and effectiveness (Mohamed Ben-Daya *et al*, 2000).

An increase in efficiency, whether it is at the production or at the consumption end, reduces the total inputs and hence, the demand for resources. In this context, the efficiency of both producer and consumer are important. The first step in improving efficiency is to measure current performance. Qualitative or subjective measurements are perfectly acceptable and appropriate in cases where quantitative methods are impractical (V. Narayan, 2003).

Identifying proper maintenance management will be involved:

- Budgetary control – it interacts with the maintenance system with the main function of controlling maintenance expenditure.
- Maintenance performance measurement and control is an information system that sets standards of maintenance performance (via maintenance objectives, key performance indices, etc), measures the actual performance and controls the overall maintenance management effort in the light of any deviations that may be observed.
- Plant reliability control is concerned with identifying equipment which is high maintenance cost or low reliability, establishing root causes of problems and prescribing solutions.
- Maintenance organizational efficiency control is an information system that is used to measure and control the efficient use of the key maintenance resources (Man power, spares and tools, etc).
- Short-term maintenance work planning and work control has the function of planning, scheduling, allocating and controlling the execution of the short-term maintenance work-load.
- Long-term maintenance work planning and control has the function of planning, scheduling, allocating and controlling the execution of the major plant shutdowns.
- Equipment spares management is the key maintenance resources. It is often managed properly in the maintenance management.
- Maintenance documentation is an information system that can be regarded as the vehicle consent to the other maintenance systems to operate and interact.

(Anthony Kelly, 2006)

4.0 The justification of this study

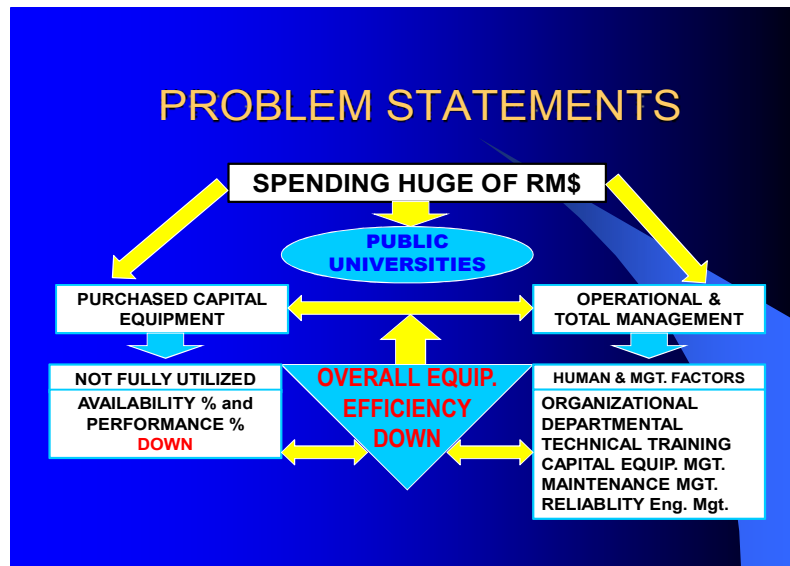
A pilot study was conducted on the use of capital equipments in selected public universities in Malaysia to find the actual OEE occurred. The components of OEE is combination three key performance measurements into one consolidated metric. It contains of Availability, Performance and Quality Efficiencies. Each performance will be calculated based on the OEE calculation as follows:

$$\begin{aligned}
 \text{Availability Efficiency (AE)} &= [(\text{Total Operation Time} - \text{Planned Downtime})/(\text{Total Operation Time})] \times 100\% \\
 \text{Performance Efficiency (PE)} &= [(\text{Total Experiment} \times \text{Actual Time})/(\text{Total Operation Time})] \times 100\% \\
 \text{Quality Efficiency (QE)} &= 100\% \text{ or } 1 \text{ (an equivalent)} \\
 \text{Overall Equipment Efficiency} &= \text{AE} \times \text{PE} \times \text{QE}
 \end{aligned}$$

Assuming that the quality factor to be the perfect result of 100% or an equivalent value. This is because the experimental product made by the machine users at the university is not for commercial purposes. However, in the manufacturing industry it is very concern and an important measurement for assessing the performance of production and processing equipment.

5.0 Statement of the problem

The structure of the problem statement as follows:



6.0 The objective of this study

The objective of this study should be defined

- 1) To identify a critical factors attributable of unavailability equipment throughout the teaching schedule.
- 2) To define any significant point of this study for organizing the resources of Overall Equipment Efficiency Model.

7.0 Methodology of this study

The method of this study is utilize a set of questionnaires and check list through observation and interview by forward it to the responsible person who accountable to each laboratory such as the Technician or Leader of the Laboratory.

8.0 Analysis of this study

The bar chart below shows the results of a survey conducted based on selected laboratory equipment at the Faculty of Mechanical and Manufacturing Engineering in one of the Malaysian public universities. The information contained in the bar chart has been described accurately and concisely with clear availability performances laboratory equipments as in Figure 1. There are displays that the result of availability performance average is 70.6%. Some of the factors affecting equipment availability that can be measured easily include (but are not limited) equipment setup time and measurement changeovers, adjustment and software programming, testing and debugging (Japan Institute of Plant Maintenance, 2007).

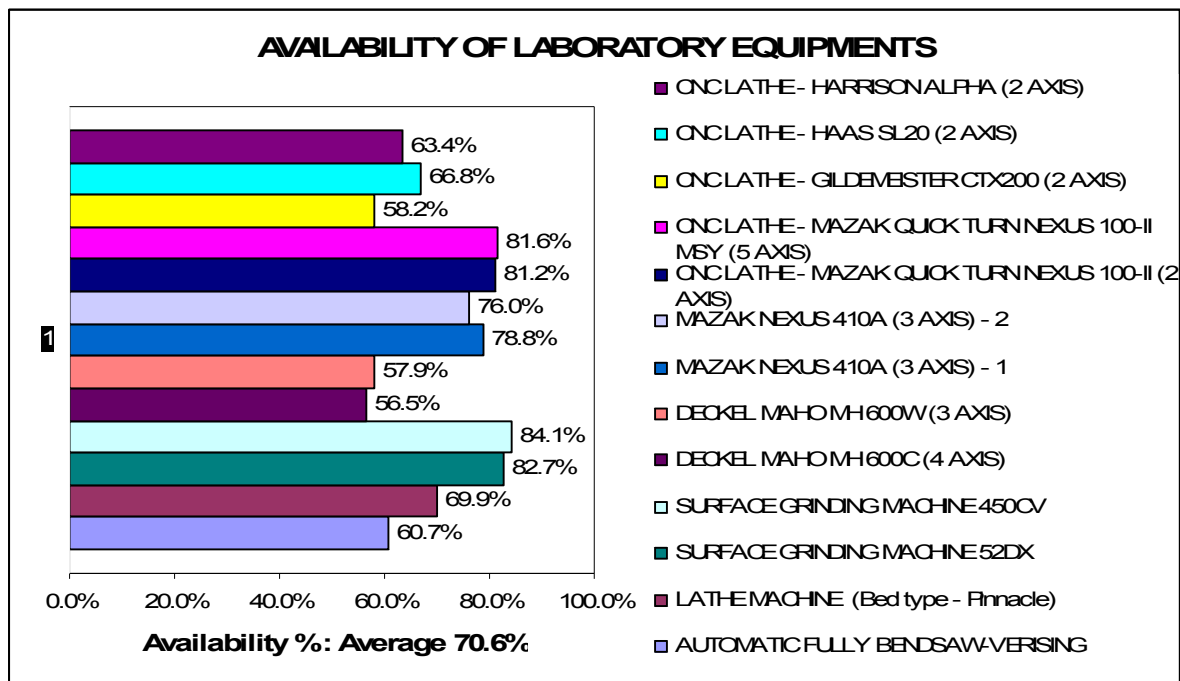


Figure 1: The availability performance of laboratory equipments

9.0 Result of this study

- 1) Unavailability laboratory equipments has been identified that the critical factors are;
 - 1.1) Equipment Availability performance trends – less than 80% based on the study analysis is considered lower availability towards fully utilize to the all laboratory equipments.
 - 1.2) The technician took a long time for mastering on the sophisticated machine before students are able to utilize for learning and researching such as CNC Lathe Machine - MAZAK Quick Turn Nexus 100-II.
 - 1.3) Troubleshooting controls – only limited for maintenance inspection is allowed as in manual operation.
 - 1.4) Major troubleshooting or modification is forbidden.
 - 1.5) Measurement tools control – no proper record expiration for tools calibrations.

- 2) Defined the important points for organizing the resources towards proper maintenance and improve the productivity of the equipments, there are:
 - 2.1) Increase the equipment utilization availability for learning and research.
 - 2.2) Management decision – the pre-requisition process to purchase equipment is not appropriate planning essentially for purchasing high-tech equipment in order to protect misspent capital.
 - 2.3) Technical Human Resources Development – essentially needed include proper training schedule for develop their technical skills and look the comparison of the equipments in recent manufacturing industry.
 - 2.4) Empowerment Skill – upgrade along with accountable person such as Machine Technician for to be more competent and talent in troubleshooting and modification skills.
 - 2.5) Overall proper maintenance system is desired.

10.0 Conclusion

The availability performances laboratory equipments as in Figure 1 shows that the result of availability performance average is 70.6%. It means the available for utilization of laboratory equipment have to improve up to 90% (Courtesy of Edward H. Hartmann, International TPM Institute, Incorporation, 2006). This study has been successfully achieved to identify critical items of the equipments which can have an impact on equipment utilization, the environment and the organizations financial performance. We are also defined the important points for organizing the resources towards proper maintenance and improve the productivity of the equipments. However, the finding is to develop a new OEE measurement model of laboratory capital equipment in public universities towards proper managing the technology of capital equipment consist utilization, performance and quality management.

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