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Implementation of total productive maintenance: A case study

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Abstract

The semiconductor industry has gone through significant changes in the last decade. Competition has increased dramatically. Customers focus on product quality, product delivery time and cost of product. Because of these, a company should introduce a quality system to improve and increase both quality and productivity continuously. Total productive maintenance (TPM) is a methodology that aims to increase the availability of existing equipment hence reducing the need for further capital investment. Investment in human resources can further result in better hardware utilisation, higher product quality and reduced labour costs. The aim of the paper is to study the effectiveness and implementation of the TPM programme for an electronics manufacturing company. Through a case study of implementing TPM in an electronics manufacturing company, the practical aspects within and beyond basic TPM theory, difficulties in the adoption of TPM and the problems encountered during the implementation are discussed and analysed. Moreover, the critical success factors for achieving TPM are also included based on the practical results gained from the study. After the implementation of TPM model machine, both tangible and intangible benefits are shown to be obtained for equipment and employees respectively. The productivity of the model machine increased by 83%.

Keywords: Autonomous maintenance; Continuous improvement; Kaizen; Performance measurement; Total productive maintenance

1. Introduction

Recent trends indicate that, in general, many systems in use are not performing as intended, so far as cost effectiveness in terms of their operation and support is concerned. Particularly in manufacturing systems, some of them often operate at less than full capacity, with low productivity, and the costs of producing products are high. According to the study reported by Mobley (1990), from 15% to 40% (average 28%) of total production cost is attributed to maintenance activities in the factory. In fact, these costs are associated with maintenance labour and materials and are likely to go even higher in the future with the addition of factory automation through the development of new technologies. Another study conducted by Wireman (1990) in 1989 stated that the estimated

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cost of maintenance for a selected group of companies increased from $200 billion in 1979 to $600 billion in 1989. The importance of maintenance function has increased due to its role in keeping and improving the availability, product quality, safety requirements, and plant cost-effectiveness levels as maintenance costs constitute an important part of the operating budget of manufacturing firms (Al-Najjar and Alsyouf, 2003).

Maintenance techniques and tools are composed of corrective, scheduled, and preventative maintenance (PM). Further detailed research by Mobley (1990) found that corrective maintenance (CM) cost is about three times higher than the same repair made in a preventative mode. Wireman (1990) estimated that only about 22% of US firms were using PM methods. As maintenance attributes a large portion of production costs, it is suggested that we look at the maintenance problems that need to be addressed:

- Insufficient proactive maintenance.
- Frequent problem repetition.
- Erroneous problem repetition.
- Sound maintenance practices not installed.
- Unnecessary and conservative PM.
- Sketchy rationale for PM actions
- Maintenance programme lacks traceability/visibility.
- Blind acceptance of OEM inputs.
- PM variability between like/similar units.
- Paucity of predictive maintenance.

In response to the maintenance and support problems encountered in manufacturing environments, the Japanese developed and introduced the concept of total productive maintenance (TPM), initially in 1971. TPM is a maintenance system defined by Nakajima (1988) in Japan, which covers the entire life of equipment in every division including planning, manufacturing, and maintenance. It describes a synergistic relationship among all organisational functions, but particularly between production and maintenance, for continuous improvement of product quality, operational efficiency, capacity assurance and safety. According to the Nakajima (1988), the word 'total' in TPM has three meanings:

1. *Total effectiveness* indicates TPM's pursuit of economic efficiency and profitability.
2. *Total maintenance system* includes Maintenance Prevention (MP) and Maintainability Improvement (MI), as well as PM. Basically, this refers to "maintenance-free" design through the incorporation of reliability, maintainability, and supportability characteristics into the equipment design.
3. *Total participation* of all employees includes Autonomous Maintenance (AM) by operators through small group activities. Essentially, maintenance is accomplished through a 'team' effort, with the operator being held responsible for the ultimate care of his/her equipment.

Moreover, the concept of TPM includes the following elements:

- TPM aims to maximise equipment effectiveness (overall efficiency).
- TPM establishes a thorough system of PM for the equipment's entire life span.
- TPM is implemented by various departments in a company.
- TPM involves every single employee, from top management to workers on the shop floor.
- TPM is based on the promotion of PM through "motivation management" involving small-group activities.

TPM is an aggressive strategy focuses on actually improving the function and design of the production equipment (Swanson, 2001). TPM aims to increase the availability/effectiveness of existing equipment in a given situation, through the effort of minimising input (improving and maintaining equipment at optimal level to reduce its life cycle cost) and the investment in human resources which results in better hardware utilisation. Another goal of TPM as stated by Schippers (2001) is to reduce and to control the variation in a process. The major objective of this paper is to study the effectiveness of an electronics manufacturing company during its TPM implementation. By attempting the introduction of TPM in this company, the practical aspects within and beyond