ELSEVIER

Journal of Operations Management 19 (2001) 39–58

JOURNAL OF OPERATIONS MANAGEMENT

www.elsevier.com/locate/dsw

The impact of total productive maintenance practices on manufacturing performance

Kathleen E. McKone [a,*], Roger G. Schroeder [b], Kristy O. Cua [b]

[a] *Babson College, Babson Park, MA 02457, USA*

[b] *Department of Operations and Management Science, Carlson School of Management, University of Minnesota, 321 19th Avenue South, Minneapolis, MN 55455, USA*

Received 2 March 1999; accepted 26 October 1999

Abstract

In this paper we investigate the relationship between Total Productive Maintenance (TPM) and manufacturing performance (MP) through Structural Equation Modeling (SEM). We find that TPM has a positive and significant relationship with low cost (as measured by higher inventory turns), high levels of quality (as measured by higher levels of conformance to specifications), and strong delivery performance (as measured by higher percentage of on-time deliveries and by faster speeds of delivery). We also find that the relationship between TPM and MP can be explained by both direct and indirect relationships. In particular, there is a significant and positive indirect relationship between TPM and MP through Just-In-Time (JIT) practices.

Keywords: Maintenance and reliability; Empirical research; Statistical analysis

1. Introduction

The purpose of this paper is to present an empirical analysis of Total Productive Maintenance (TPM). While Just-In-Time (JIT), Total Quality Management (TQM) and Employee Involvement (EI) have been recognized as strong contributors to manufacturing performance (MP) both in the practitioner literature (Schonberger, 1986, Miller and Schenk, 1997) and the academic literature (Cleveland et al., 1989; Flynn et al., 1995; Jarrell and Easton, 1997; Sakakibara et al., 1997), there has been limited recognition (Maier et al., 1998) of the role that maintenance plays in improving MP. However, TPM can be thought of as integral to a World Class Manufacturing Strategy that also involves JIT, TQM, and EI. In particular, Schonberger (1986) argues that JIT, TQM, EI, *and* TPM are critical components of World Class Manufacturing. Therefore, it is hypothesized that companies that implement TPM will not only be able to enhance their maintenance practices but also improve their MP.

This paper focuses on the relationship between TPM and MP. We propose a conceptual framework to examine the nature of this relationship. Since TPM, JIT, and TQM are critical to a world class manufacturing strategy, we believe that it is necessary to consider JIT and TQM when assessing TPM. Therefore, our framework considers both direct and indirect relationships (through JIT and TQM) between TPM and MP. After

* Corresponding author. Tel.: +1-781-239-4245; fax: +1-781-239-5272.
E-mail address: kmckone@babson.edu (K.E. McKone).

0272-6963/01/$ – see front matter
PII: S0272-6963(00)00030-9

proposing our framework, we then test it using survey data collected from 117 plants across three industries and four countries.

The remainder of this paper is organized as follows. In Section 2 of the paper, we define our model and our hypotheses. In Section 3, we describe our data. In Section 4, we discuss the measurement of our model variables. In Section 5, we present our analysis approach. Then, in Section 6, we present and discuss the results from our study. Finally, we present our conclusions.

2. Framework definition

In this section, we define the components of our framework (shown in Fig. 1) relating TPM and MP. After discussing the components of the framework, we present the theory that supports this framework and discuss the hypothesized relationships that will be analyzed in this paper.

2.1. TPM elements

Seiichi Nakajima, vice-chairman of the Japanese Institute of Plant Engineers (JIPE), the predecessor of the Japan Institute of Plant Maintenance (JIPM), promoted TPM throughout Japan and has become known as the father of TPM. In 1971, TPM was defined by JIPE as follows:

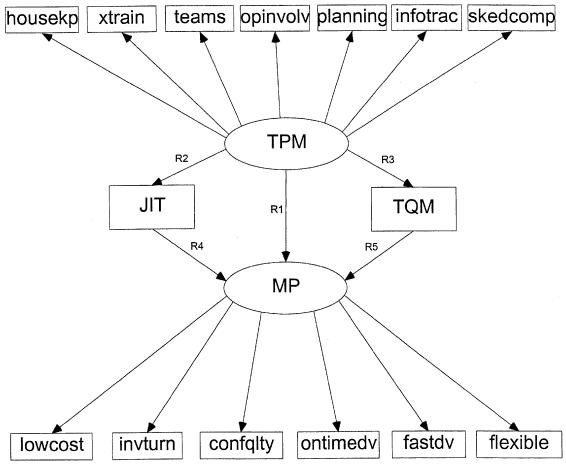

Fig. 1. Framework.

> TPM is designed to maximize equipment effectiveness (improving overall efficiency) by establishing a comprehensive productive-maintenance system covering the entire life of the equipment, spanning all equipment-related fields (planning, use, maintenance, etc.) and, with the participation of all employees from top management down to shop-floor workers, to promote productive maintenance through motivation management or voluntary small-group activities. (Tsuchiya, 1992, p. 4)

TPM provides a comprehensive company-wide approach to maintenance management, which can be divided into long-term and short-term elements. In the long-term, efforts focus on new equipment design and elimination of sources of lost equipment time and typically require the involvement of many areas of the organization. In this paper, we focus on the short-term maintenance efforts that are normally found at the plant level of the organization. In the short-term, TPM activities include an autonomous maintenance program for the production department and a planned maintenance program for the maintenance department.

Throughout this paper, we measure TPM as in McKone et al. (1999). We consider seven elements of TPM in the paper: four elements of autonomous maintenance — *housekeeping* on the production line, *cross-training* of operators to perform maintenance tasks, *teams* of production and maintenance personnel, and *operator involvement* in the maintenance delivery system; and three elements of planned maintenance — *disciplined planning* of maintenance tasks, *information tracking* of equipment and process condition and plans, and *schedule compliance* to the maintenance plan. These seven elements will be discussed in more detail in Section 4, when we discuss the measurement of our framework variables.

2.2. MP dimensions

There are many different ways of measuring MP. However, the most predominant approach in the literature is to use cost, quality, delivery, and flexibility as the four basic dimensions of MP. In some studies, these dimensions have been expanded to include several additional measures (Hayes et al., 1988; Miller