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Towards an holistic understanding of disruptions in Operations Management

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Abstract

The paper reviews the literature on maintenance management, integrates key dimensions of maintenance within a taxonomy of maintenance configurations, and explores the impact of differing configurations on contextual factors and operational performance. "Prevention", "hard maintenance integration" and "soft maintenance integration" were identified as key maintenance variables. Data were collected from 253 Swedish manufacturing companies, and three distinct clusters were identified. "Proactive Maintainers" emphasized preventive maintenance policies. "IT Maintainers" relied on computerized and company-wide integrated information systems for maintenance. "Maintenance Laggers" emphasized all maintenance dimensions to lesser extent than the others. The importance of maintenance prevention and integration differ between contexts. There were subtle performance differences across identified configurations, but preventive and integrated maintenance were more important for companies seeking competitive process control and flexibility. There existed no group with any great emphasis on all three maintenance dimensions, but attaining truly high performance may require a rare mix of the three dimensions. This mix of variables could constitute a hypothesized "World Class Maintenance" group.

Keywords: Operations strategy; Maintenance; Productivity

1. Introduction

Holistic and proactive concepts, such as Lean Production, Just-in-Time, Total Quality Management (TQM), Concurrent Engineering and Supply Chain Management, are becoming important for companies seeking lean processes with short through-put time and zero defects. In most plants, the physical equipment is susceptible to failure through breakdown, deterioration in performance through age and use, and to obsolescence due to improvements in technology. However, the rising importance of "streamlining" the processes and achieving process control and flexibility raises the cost of disturbances, and thus increases the need for reliable and consistent equipment without quality problems.

Error-free production with a minimum of stoppages, speed losses and quality defects are, however, still uncommon in industrial practice. Studies indicate overall equipment efficiencies (defined by Nakajima, 1988, as Availability × Performance efficiency × Rate of quality product) in the 40% to 70% range (Ljungberg, 1998; Ericsson, 1997), due to frequent process disturbances. These disturbances may lead to production losses and other indirect "hidden" costs (e.g. bad internal and external environment and safety of operators) that affect the

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overall performances of the organizations, for example in terms of higher direct production costs, longer through-put times, lower product quality and low customer service. A main reason for disruptions and unavailability in the production equipment is often considered to be the absence of proper maintenance (e.g. Nakajima, 1988; Ericsson, 1997). Therefore, maintenance should have an important role in operations management research and practices, yet this is not supported by current literature.

This paper seeks to fill some of the gaps in the literature on maintenance within operations strategy. The objectives are to review the literature on maintenance management, integrate *key dimensions of maintenance* within a *taxonomy of maintenance* configurations, and explore the impact of differing configurations on *contextual factors* and *operational performance*.

The growing use of advanced information and manufacturing technologies, such as electronic data interchange, enterprise resource planning, activity based costing, flexible manufacturing systems, robotics, and automatic handling systems, may help companies to achieve competitive process control and flexibility. Research in operations strategy has clearly shown that "learning organizations" with decentralized authority and empowered personnel are important prerequisites for achieving the full potential of investments in technology (e.g. Dean et al., 1992; Maffei and Meredith, 1994; Chen and Small, 1996; Boyer et al., 1997). There was only one study to be found on advanced manufacturing technology (Jonsson, 1999), which emphasized the importance of maintenance, and explained that it is a key variable for achieving high performance in advanced manufacturing technology environments.

Maintenance is also a key missing variable in existing works that have explored configurations of operations strategy and infrastructure, and their varied impact on performance. Those studies focusing on the competitive capabilities of operations strategy (Miller and Roth, 1994; Sweeney, 1991, 1993) are very well cited and have become "basic theory" in operations management. Another taxonomy describing manufacturing structure and infrastructure is also valuable for understanding the role of infrastructure in high-tech companies (Boyer et al., 1996). These configurations are important contributions to operations strategy, but development of a maintenance taxonomy that links maintenance to operations strategy and performance would further the theory and practical development of operations strategies.

The paper is structured according to the objectives. First we discuss the development of the maintenance discipline, review the present maintenance literature, and identify three key variables within a cohesive maintenance management approach. Cluster analysis is then employed to identify an empirical maintenance taxonomy based on the three maintenance variables. Survey data is collected from seven Swedish manufacturing industries that together represent the majority of Swedish manufacturing companies. The similarities and differences of contextual factors and operational performance between the three identified clusters are explored by comparing means of the clusters. The paper ends with a discussion on the findings and limitations of the conducted study.

2. A maintenance management framework

This section discusses the development of the maintenance discipline and describes maintenance prevention, integration (soft and hard), and context in more detail.

2.1. Present maintenance approaches and configurations

The development of the maintenance discipline has been influenced by academic disciplines, such as industrial engineering, operations research and business administration. It started as an engineering topic, then operations research was included, and now also more emphasis is on the business and management disciplines. The development is driven by the need of industry, but as Sherwin (1999) states; "maintenance management has always developed somewhat behind the current requirements".

During the last decades much emphasis has been put on *prevention* and *company-wide integration* of maintenance. It is becoming too expensive to run the equipment until breakdown, and instead various preventive policies are developed. Maintenance activities are integrated into other business disciplines at