Changeable, Agile, Reconfigurable & Virtual Production

Use of maintenance performance indicators by companies of the industrial hub of Manaus

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Abstract

The study presented in this paper aims to identify and analyze the use of maintenance performance indicators adopted by companies of the industrial hub of Manaus in Brazil. A questionnaire was developed and sent to the companies of the industrial hub and the received data was analyzed in order to identify behaviors of companies concerning the use of performance indicators of the maintenance area. The results showed that the use of performance indicators in maintenance area is low and is dependent on the number of equipment, maintenance staff size, Total Productive Maintenance adoption and Computerized Maintenance Management utilization. Another finding is that local and international companies have different behaviors concerning performance evaluation. This study is part of a project that aims proposing different levels of maturity in this area and identifying the determinants factors to achieve higher levels of efficiency and effectiveness.

1. Introduction

Maintenance is becoming increasingly important due to the new paradigms of production such as Lean Manufacturing, having highly impact on product quality and productivity and therefore on production costs and customer satisfaction.

Maintenance management is defined by EN13306 [1] as all activities of the management that determine the maintenance objectives, strategies, and responsibilities and implement them by means such as maintenance planning, maintenance control and supervision, improvement of methods in the organization including economical aspects.

Tsang [2] states that maintenance performance measurement is needed for the purpose of giving the maintenance manager quantitative information about maintenance goals that can be reached and what actions are needed to be taken in order to improve the operation results to meet the goals.

The literature, in the context of maintenance, provides various expressions and terminologies for performance indicators.

There are many performance indicators available in EN15341 [3] and in many others publications such as: Gulati [4], Campbell [5], Muchiri et al. [6], Wireman [7].

However, very few indicators are really used by companies and its use depends on the level of development of this area.

The objective of this research is to empirically study the utilization of maintenance indicators and the factors that hinder, encourage or facilitate its use. Through a survey, data was collected about the maintenance performance indicators adopted by the maintenance area of companies of the Industrial hub of Manaus in Brazil.

Based on the obtained results, hypotheses are tested in order to analyze if the adoption of performance indicators is linked to companies practices or characteristics such as size, number of equipment, and use of a computerized maintenance management system (CMMS), among others.

Therefore, the study seeks to answer the following questions:

• What are the practices concerning maintenance performance indicators in companies operating in Manaus Industrial hub?
• Is the adoption of performance indicators associated with different factors, such as the number of equipment or number of members of the maintenance team, the adoption of maintenance methodology such as Total Productive Maintenance (TPM) or owning a CMMS that allows the calculation of indicators?

• Is the behavior of local and international companies similar concerning performance evaluation?

This paper is organized as follows. The second section presents literature review about maintenance performance measurement and performance indicators. The third section presents data collection and results analysis. The last section presents the conclusion.

2. Maintenance performance measurement

The measurement of performance allows identifying performance gaps between current and desired performance and provides indication of progress towards closing the gaps (Weber [8]). Following the author, managers must set a clear direction, focusing on the company vision and they must adopt management tools to help them steer the organization and to monitor and evaluate the progress. All functions and levels of management require a kind of performance measure, and when defining these measures, maintenance leaders have to understand its need, precision, source and applicability in order to indicate those that are most suitable, among many available. Muchiri et al. [6] sustain that indicators should support the monitoring and control of performance, help the identification of performance gaps, support learning and continuous improvement, support maintenance actions towards attainment of objectives and provide maintenance resources to areas that affect manufacturing performance. In general, indicators are measures or numerical data set about processes that we want to control and improve.

Several authors have discussed the design of performance indicators, such as Crawford and Cox [9], House and Price [10], and all claim that performance measures must be clear, meaning simple to understand, must have visual impact, should focus on improving and be visible to everyone.

The literature provides various expressions and terminology for performance indicators. Wireman [7] proposed a set of performance indicators to support maintenance management related to preventive maintenance, purchasing, workflow systems, CMMS, asset management systems (EAM), training technical and interpersonal, predictive maintenance, operational involvement, Reliability Centered Maintenance (RCM), TPM, statistical financial optimization and continuous improvement.

EN15341 [3] highlights that maintenance performance is the result of complex activities, which can be evaluated by appropriate indicators to measure actual and expected results, grouping them in economic, technical and organizational indicators.

Arts et al. [11] discuss performance indicators for the evaluation of the maintenance activities indicating that performance measurement is needed on the strategic, tactical and operational levels.

According to Muchiri et al. [12], companies customize indicators to fit their industrial requirements. Therefore, the activity sector, the amount of equipment, the maintenance staff size may influence the behaviours of companies concerning the use of performance indicators.

Kumar et al. [13] indicate that predefined performance

indicators can be incorporated into various CMMS software and reports. When a computerized system is adopted, the calculation of performance indicators is easier and allows making analyses and comparisons with the goals.

Many authors believe that the level of maturity and organizational culture are determinant factors for the results to be achieved (Marquez & Gupta [14]; Garg & Deshmukh [15]; Fernandez & Labib [16]). Bortolotti et al. [17] sustain that organizational culture is crucial for implementing the Lean methodology and many authors follow similar statement (Liker [18]; Atkinson [19]). McDermott [20] shows that cultural characteristics are significantly related to advanced manufacturing technology (AMT) and that culture does have a connection to this area. Alsyoulf [21] identifies many maintenance practices in Swedish industry but did not analyze whether there were differences related to cultural aspects or origin of the companies. Some authors consider that the origin of the company can affect the organizational culture (Folan [22]; Valmohammadi [23]; Craig [24]). Consequently, it seems relevant to analyze of the influence of companies origins in their behaviors concerning performance evaluation.

3. Data collection and analysis

This paper presents results from a survey named *Study of Maintenance Practices Adopted by Companies in the Manaus Industrial Pole.* The survey intends to study the organization and maintenance management practices adopted by Manaus industrial hub companies, in Amazonas state (Brazil).

The Industrial hub of Manaus is one of the most modern in Latin America, bringing together major industries, local and international, in the areas of electronics, motorcycles, optical products, computer products, chemical industry.

There are approximately 430 companies registered and operating in the industrial hub of Manaus, according to the official document provided in 2014 by Suframa [25], which is the agency that manages the industrial hub of the region.

The questionnaire was sent by email to all companies registered in the industrial hub and was addressed to the main responsible of each managing maintenance department. The sample has a total of 72 respondents, resulting in a response rate of 16.74%.

The maintenance manager's position was mainly maintenance coordinator or maintenance leader (52.78%) and maintenance supervision (27.78%). Subsequently, based on the company activity sector, each respondent company was classified in one area of activity: 1) electrical & electronic; 2) metallurgical/metal-mechanic, 3) automotive industry & components, 5) plastics & molding injection, 7) food, 8) personal care and 9) others. The results are summarized in Table 1.

Table 1. Respondents position (n=72)

Maintenance Position	Percentage
Coordinator or Leader	52.78%
Supervisor	27.78%