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Identification of problems in maintenance operations and comparison with manufacturing operations

A review

Sandeep Phogat
Department of Mechanical Engineering, Amity University Haryana, Gurugram, India, and
Anil Kumar Gupta
Department of Mechanical Engineering, Deenbandhu Chhotu Ram University of Science and Technology, Murthal, India

Abstract

Purpose – In the present context of globalization, maintenance of production systems is very important. A lot of organizations are facing many problems in maintenance management. Therefore, the purpose of this paper is to identify the main problems in maintenance operations and compare these problems with those in manufacturing operations as found in the literature for effective maintenance.
Design/methodology/approach – To identify the main problems in maintenance operations and to compare them with those in manufacturing operations, a large amount of published literature was studied. The paper systematically categorizes the published literature and then analyzes and reviews it theoretically.
Findings – Lack of top management support, lack of measurement of overall equipment effectiveness (OEE), lack of strategic planning and implementation and many more problems are biggest problems in the maintenance operations as well as manufacturing operations. These have emerged as top problems in the implementation of effective maintenance strategies in industries.
Research limitations/implications – From the findings, the authors can conclude that for good maintenance, top management is supposed to be supportive in taking different initiatives. Industrial organizations should focus on improving overall performance of machines identified as OEE rather than only productivity of machines. This paper will be extremely useful for the researchers, maintenance professionals and others concerned with maintenance to understand the significance of maintenance problems in industries.
Originality/value – These findings will be highly useful for professionals from the manufacturing sector in implementing effective maintenance strategy in the maintenance management system.

Keywords Manufacturing, OEE, Quality, Productivity, Maintenance

Paper type Literature review

1. Introduction

Due to the briskly changing scenario of globalized markets, most of the organizations around the globe are worried due to increasing competition and changing consumers' demands for quality products at lowest costs (Chandra and Shastry, 1998). In this context, many local firms are losing their market (Khanna and Sharma, 2011). Singh and Sharma (2015) and Phusavat and Kanchana (2008) have noticed that various factors to gain competitiveness are as follows: flexibility, quality, reliability and ability to meet demand and supply requirements. Most of the organizations are trying to improve manufacturing flexibility (Singh and Sharma, 2014). So it is essential for such firms to focus on effective maintenance systems. Alsyouf (2007) and Ahmed *et al.* (2005) have noticed that cost reduction can be achieved by increasing the level of automation in different operations. Automation decreases the requirement of workforce significantly; however, since the complex machinery is involved in automation, maintenance has a significant role here

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(Ahuja and Khamba, 2008; Hansson and Backlund, 2003; Garg and Deshmukh, 2006). Thus, there is a requirement of responsive maintenance department if organizations want to do extremely well in service and subsequently want to raise their market share.

Due to the increasing technical advancements, the stimulus of productivity and quality is moving from man to machine. Productivity and quality may be increased only by implementing well-developed and organized maintenance system. So it is significant to understand the problems faced by the organizations, and they should be managed by experienced maintenance managers (Mohamed, 2005).

Before the manufacturing revolution in England near the mid-18th century, maintenance was only adopted by craftsman such as carpenters, black smiths and masons in their work, which was mostly done through repairing or making a new part. At that time, it was very difficult to perform maintenance as working conditions were tedious. However, after the improvement in the upkeep field, Jefferson (1785) observed that the parts were being made precisely and they could be traded. These small but increasing developments slowly made the maintenance work easier. As maintenance work requires more budget, it is considered as an "essential evil" by top management (Eti *et al.*, 2007; Cooke, 2003). However, this attitude is being replaced by the one which regards maintenance as the control of reliability and a tactical issue (Eti *et al.*, 2006). The magnitude of maintenance in cost manage, saving time and others assets by optimizing their production ability and increasing the overall equipment effectiveness (OEE) has been understood by the business leaders worldwide. They are at the present using it as a competitive tool to increase profits (Sherwin, 2000). Due to the increasing advancement in the production technology, many models have come into continuation like the Eindhoven University of Technology model, total productive maintenance (TPM), total quality maintenance, reliability-centered maintenance (RCM) and condition-based maintenance (CBM). Presently, the diverse upgrades, for example, low absconds and blunders and lessened waste, can be accomplished just by expanding machine practicality (Kaynak, 2003; Brah *et al.*, 2002; Hendricks and Singhal, 2001; Hansson and Eriksson, 2002). Cholasuke *et al.* (2004) have noticed that even after implementing the proper maintenance models for achieving productivity goals, the organizations are failing to accomplish performance targets because of different problems involved in accomplishment of maintenance system. Cooke (2000) has recognized issues with execution of TPM in light of contextual analyses; however, he has not positioned the recognized issues. So the objectives of this study are to identify major problems in effective maintenance operations and then compare them with those faced in manufacturing operations. The remaining paper is structured as follows: Section 2 deals with maintenance definition and different maintenance strategies, Section 3 deals with literature review for identifying the problems of maintenance operations and their comparison with manufacturing operations and finally Section 4 presents the concluding remarks.

2. Maintenance definition and strategies

2.1 Maintenance definition

Maintenance is defined according to the European standard EN 13306:2001 (2001) as: "the combination of all technical, administration and management actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can deliver the required function (function or a combination of functions of an item which are considered necessary to provide a given service)."

This definition explains the endeavor of maintenance, and it can help us to understand which part of an organization is, somehow, fervent to maintenance. We can define maintenance management according to the European standard EN 13306:2001 (2001) as follows:

> All the activities of the management that determine the maintenance aims or priorities (defined as targets assigned and accepted by the management and maintenance department), strategies

(defined as a management method required to achieve maintenance objectives), and responsibilities and implement them by the help of maintenance planning, maintenance control and supervision, and several improving methods including economic aspects in the organization.

Dhillon (2006) defines maintenance as "a collection of actions executed on an asset with the aim of keeping an asset in, or restoring it to, a specified condition." The maintenance function is an essential part of any asset of an intensive organization and is needed to maintain the organization's business objectives.

2.2 Maintenance strategies

Maintenance strategies involve different types of tasks which include actions, procedures, resources and time. These tasks have to be carried out in accordance with established time schedules to guarantee maintenance targets. Maintenance planning is the activity of planning maintenance actions, e.g., inspection, replacement, overhaul and repair. In particular, maintenance planning schedules interventions over time and identifies and allocates necessary resources for the implementation of maintenance strategies. Obviously, planning is followed by the execution of maintenance actions and also by the control and supervision of the production systems: on-site, i.e., at the location where the item is used; online, i.e., during the time that the item is used; remotely, i.e., without physical access to the item, etc. Maintenance strategies and planning can be properly updated on the basis of the feedback data extracted from the item performances. All these activities have to be properly supported by a maintenance support system made up of resources, services and management. The configuration of such a support system depends on many factors, such as the complexity of maintenance tasks, the skill of the personnel, availability of the facilities, etc. and is therefore a very critical issue in maintenance management. Four different maintenance strategies are introduced as following.

2.2.1 Corrective maintenance. This option support technique is likewise called putting-out-fires upkeep, disappointment-based support, or breakdown upkeep. In the remedial support procedure, upkeep is not executed until the disappointment happens (Swanson, 2001). Restorative support is a well-known upkeep technique found in industry (Waeyenbergh and Pintelon, 2002; Mechefske and Wang, 2003). It is considered as an appropriate approach in the cases where profit margins are large (Sharma *et al.*, 2005). In any case, such a putting-out-fires technique for upkeep regularly causes genuine harm to related facilities, workforce and environment. To further it, increments in worldwide rivalry and little overall revenues have constrained support supervisors to apply more powerful and dependable upkeep systems.

2.2.2 Time-based preventive maintenance. According to trustworthiness characteristics of equipment, maintenance is performed and planned periodically to decrease frequent and sudden failure. This maintenance approach is called time-based preventive maintenance, where the term "time" may refer to operating time, calendar time or age of the asset. Time-based preventive maintenance is extremely useful in industry. For performing time-based preventive upkeep, a choice emotionally supportive network is required, and it is frequently hard to characterize the best support interims in light of lacking adequate chronicled information (Mann *et al.*, 1995). By and large when time-based support techniques are utilized, most machines are kept up with a lot of helpful life remaining (Mechefske and Wang, 2003). This regularly prompts superfluous support, even decay of machines if inaccurate upkeep is executed.

2.2.3 CBM. Maintenance decision is made in condition-based monitoring depending on the data measured from a set of sensors systems. Today a number of monitoring techniques are available, such as ultrasonic testing, lubricating analysis and vibration monitoring. The checked data of equipment parameters can tell the engineers whether the situation is

normal, allowing the maintenance staff to implement necessary maintenance before failure happens. This maintenance procedure is regularly utilized for turning and responding machines, e.g., turbines, divergent pumps and compressors. In any case, impediments and inadequacy in information scope and quality lessen the viability and exactness of the CBM approach (Al-Najjar and Alsyouf, 2003).

2.2.4 Predictive maintenance. In the literature survey, predictive maintenance is often referred to the same maintenance strategy as the CBM (Sharma *et al.*, 2005; Mobley, 2002). Predictive maintenance is utilized to speak to the support methodology that can conjecture the impermanent pattern of execution debasement and foresee flaws of machines by breaking down the checked parameters information. Deficiency prognostics is the most recent system utilized by maintenance administration, which gives maintenance engineers the likelihood to arrange support taking into account the season of future disappointment and co-occurrence support exercises with production plans, clients' requests and workforce accessibility.

Recently, the smart maintenance system was described by Djurdjanovic *et al.* (2003), focusing on mistake in prognostic techniques and aimed towards achieving near-zero-downtime performance of equipment. It is significant mentioning that the equipment failures and corrective procedures of maintenance cannot be skipped completely when preventive maintenance approaches (including the time-based, condition-based and predictive maintenance) are applied. This is due to the stochastic nature of the equipment failure. However, the equipment failure can be reduced if the preventive maintenance approaches are correctly selected and implemented.

3. Problems identification in maintenance operations and problems comparison with manufacturing operations

Presently, all the maintenance operations are in the compass of accomplishing the world-class level of maintenance and its credit goes to the robotization in the organizations (Ahmed *et al.*, 2005; O'Sullivan *et al.*, 2011). Nonetheless, human inputs are still a critical element. Abilities of the normal maintenance administrator or laborer are required for mechanized and innovatively advanced equipment, and most essentially, a suitable and successful maintenance organization is required to utilize it viably (Mohamed, 2005). According to Poduval *et al.* (2015), time, manpower, money, commitment and resources from all the stakeholders are requisite to implement maintenance job in industries. The organization as a whole should be willing to change its outlook and adapt to the new practices and cultural changes which are compulsory for the growth and accomplishment of maintenance models. There are many problems in implementing effective maintenance in organizations. Significant problems were identified from the literature and summarized in the Table I.

3.1 Lack of benchmarking

Benchmarking is an uninterrupted process to be in motion towards best in group by achieving large level of maintenance effectiveness standard frequently (Ahren and Parida, 2009; Raouf and Ben-Daya, 1995). The preliminary benchmarking helps in filling the gap between the established equipment condition as well as the preferred manufacturing excellence (Ahuja and Khamba, 2007). The main concern of benchmarking from the maintenance point of view is defects in equipment or degradation in quality of manufacturing equipment and unplanned downtime (Raouf and Ben-Daya, 1995). Efficient benchmarking of diverse processes ensures customer satisfaction and product quality (Singh, 2011).

It is conceivable by measuring ones execution as for the "best in class" entertainer (Hansson and Backlund, 2003). It helps in distinguishing its qualities and shortcomings and

Sl no.	Problems in maintenance operations	References
1.	Lack of benchmarking	Adebanjo *et al.* (2010), Singh (2011), Shaaban and Awni (2014)
2.	Lack of communication and information	Mohamed (2005), Leong *et al.* (2012)
3.	Lack of empowerment	Yongtao *et al.* (2014), Poduval *et al.* (2015)
4.	Lack of teamwork	Rolfsen and Langeland (2012), Aspinwall and Elgharib (2013)
5.	Lack of commitment of employees toward maintenance	Singh and Ahuja (2014), Mosadeghrad (2014)
6.	Lack of training	Singh *et al.* (2013), Mosadeghrad (2014)
7.	Lack of proper strategic planning and implementation	Singh *et al.* (2010), Abreu *et al.* (2013), Mosadeghrad (2014), Ding *et al.* (2014)
8.	Lack of top management support	Kodali *et al.* (2009), Singh *et al.* (2008), Kumar *et al.* (2015)
9.	Lack of awareness about safety and health	Grusenmeyer (2010), Singh *et al.* (2013), Narayan (2012)
10.	Lack of effective performance measurement	Parida and Kumar (2009), Lad and Kulkarni (2010a)
11.	Lack of measurement of OEE	Pophaley and Vyas (2010), Lad and Kulkarni (2010b)

Table I.
Maintenance operation problems summary

gives an ability to read a compass to the arrangement. It is a five-stage process: planning, examination, integration, activity and implementation and result (Raouf and Ben-Daya, 1995). Shortening of benchmarking causes low reliability and poor maintainability (Hansson and Backlund, 2003).

3.2 Lack of communication and information

Communication and information in an industry implies meaningful and open communication in such a way that information flows tangentially creating an unwrapping atmosphere in the organization (Mosadeghrad, 2014). It includes informal meetings between administration and union representatives to complement formal communications that help in increasing interest and acceptance. Lad and Kulkarni (2010a) have projected a mechanism to association of operational requirements through machine tool maintenance and reliability parameters, where workers involvement and understanding could be achieved (Abraham *et al.*, 1999; Pintelon *et al.*, 1999; Tsang and Chan, 2000; Hansson and Backlund, 2003). Due to lack of communication and information, not flowing laterally, workers of an organization are not capable to report and identify the sources of reliability and maintenance and are not capable to put their precious suggestions for enhancement (Hansson and Backlund, 2003).

3.3 Lack of measurement of OEE

OEE is the evaluation of usefulness of the equipment or machine; it is the performance indicator (Rolfsen and Langeland, 2012). It depends on three parameters: quality rate, system availability rate and performance rate. The main purpose of maintenance process is to boost OEE, and due to improper evaluation of OEE, maintenance activities cannot be implemented properly (Kumar *et al.*, 2014). The progress of the business depends mainly on the above mentioned three parameters of OEE (Prickett, 1999). System availability refers to the rate of availability of machine tool. Availability depends on the system design which determines reliability and maintainability of the system with the increment in effective functioning of system (Lad and Kulkarni, 2012). Execution rate lets us know about the misfortunes caused because of utilization of machine at low execution rate, and the corruption of execution is for the most part because of incomplete maintenance work (Al-Sultan, 1996). Quality rate submit to the losses come in the place due to the bad quality and which becomes the primary reason of more rejections in the production lines (Prickett, 1999). Removal of waste such as rework and scrap can be easily achieved by quality improvement which gives better productivity and thus leads to reduced cost. Continuous

improvement of above mentioned three main parts of OEE should be an important target. The analysis of these factors can be used for improvement of individual tool reliability and importantly to stop the repetition of similar type of failures in a machine tool (Prickett, 1999). However, if the organization fails to determine OEE, then it is not capable of monitoring important factors affecting performance of the system. Lad and Kulkarni (2010b) have recommended parameter estimation technique for the machine device reliability examination to overcome the difficulty of unavailability of the precise breakdown data collection method.

3.4 Lack of teamwork

Team working explains involvement of whole organizations to reduce the defects, i.e., an industry-wide strategy to achieve excellence where the responsibilities of all the employees are crucial (Graham *et al.*, 2014; Ledet, 1999). It also helps in achieving better reliability at lower cost (Ledet, 1999). Not only the maintenance section but also the entire association should ensure the reliable and dependable maintenance system (Madu, 2000). Traditional factors of maintenance administration such as information system and data collection are still significant and input factors to get better reliability and maintainability. These input factors must be synchronized in an interconnected form (Hansson and Backlund, 2003). However, many managements have reported that team working between the production and maintenance department is not only an issue of principle but also an issue of practicability (Cooke, 2000). Many experiments have shown that proper maintenance activities can be performed when the whole business unit works towards a common goal, or else sub-optimization will effects in unachieved targets (Rolfsen and Langeland, 2012).

3.5 Lack of effective performance measures

For maintenance systems' effectiveness, apart from OEE, other performance measures are also equally important. Due to the substantial cost of maintenance as compared to operational cost, measuring of good performance becomes most important to survive competition and still being cost-effective. Usually maintenance measures are not a part of performance framework. In favor of this, framed audits can be voted for to measure efficiency and to recognize area of enhancement (Raouf, 1994; Raouf and Ben-Daya, 1995). To monitor and to take timely decisions, the information about the output of machine is most important, and shortage of this information causes ineffective and inefficient maintenance process (Parida and Kumar, 2009).

3.6 Lack of commitment of employees

According to Davis (1997), many manufacturing organizations failed to employ maintenance system accurately due to demoralized and reluctant production department workers; they were in fear of losing job and were unwilling to do stressful work as they do not see the profits of implementations due to the lack of knowledge (Hardwick and Winsor, 2001; Karlsson and Ljungberg, 1995; Shin *et al.*, 1998). This can be overcome by perceiving the workers and unmistakably demonstrating to them the advantages of executions (Allen and Kilmann, 2001; Hartmann, 1992). Since activities are actually implemented by the workers, employees who lack positive thinking towards maintenance further increase the cost of maintenance (Hansson and Backlund, 2003). Due to this, fewer resources are spent on other aspects of maintenance.

3.7 Lack of training

Effective working of maintenance department requires that the managers and employees have the appropriate knowledge, skills and expertise in the field of quality management

(Mosadeghrad, 2014). It helps in changing the mind set of employees from traditional maintenance approach to the new and modern approach. It further aides in lessening the maintenance crew and expands adaptability, as small maintenance jobs could then be done by the normal maintenance staff or the work floor specialists (Nembhard, 2014). It also increases the commitment and brings about positive behavioral changes. Training is required with adequate measure of reasonable learning; generally representatives have a tendency to overlook what they were taught (Hansson and Backlund, 2003). For example, a untrained planner would not be capable of determining job content, duration, number of workers required, number of spare parts required, etc. (Raouf and Ben-Daya, 1995).

3.8 Lack of proper strategic planning and implementation

Strategies set directions for deciding operation functions to ensure competitiveness (Singh *et al.*, 2010). These are the functions that help in integrating the quality requirement with the business activities (Chin *et al.*, 2002). These are the behaviors to identify and overcome barriers in achieving the most wanted goals (Hartmann, 1992; Hipkin and Lockett, 1995; Shin *et al.*, 1998). They help in encouraging the subsequent meet-ups and checking the accomplishments like association of employees and comprehension among administration and worker by setting objectives and identifying solutions (Abraham *et al.*, 1999; Schwan and Khan, 1994). It also relates to maintenance works with organization's vision, mission and strategies (Bardoel and Sohal, 1999; Riis *et al.*, 1997). It is observed that lack of proper strategic planning and implementation can prove to be a bottleneck due to the unclear picture of benefits to organization from these improvements (Abreu *et al.*, 2013).

3.9 Lack of top management support

Atkinson (1990) and Jaehn (2000) have analyzed that maximum number of firms fail due to lack of top management support. Implementation of maintenance actions in organizations requires major resources like human resources, money and time. Top management is accountable for providing these resources (Shin *et al.*, 1998; Hansson and Backlund, 2003). It has become very important to change from traditional methods and organization structure to the new and modern one (Singh *et al.*, 2008). Therefore, one of the major job of top management in the current context of business environment is to reorganize the established organization reporting structure to obtain the maintenance quality and reliability information on timely basis (Hansson and Backlund, 2003). Major assets need proper accomplishment with clear perceptive of methodologies and objectiveness of maintenance systems (Clark, 1991; Hipkin and Lockett, 1995). The most important objective of maintenance is to expand OEE and not to decrease the work tally. Asjad *et al.* (2013) have recommended supportability-based contract options for operating life of mechanical frameworks. As indicated by them, supportability for a client is the capacity of the maker to execute all the bolster exercises that are required for maintenance of the system, in its best effective and auspicious way all through the operating life of the equipment, at whatever point and wherever required.

3.10 Lack of empowerment

For viable maintenance of administration and manufacturing operations, worker strengthening for taking diverse choices at own levels is critical. Strengthening intends to build up the groups and to fabricate a developed staff (Mohamed, 2005). Representatives ought to be dynamic members and fulfilled by their employment with sentiment possession (Hansson and Backlund, 2003; Aghazadeh, 2002; Yamashina, 2000). To utilize maintenance for upper hand, associations ought to engage workers to adjust forms according to natural changes (Douglas and Judge, 2001). Lack of empowerment means latent interest of workers; hence there is decrement in effectiveness of maintenance procedure and productivity.

3.11 Lack of awareness about safety and health

For the success of any enterprise, an important prerequisite is the safety of people, environment and assets (Narayan, 2012). According to survey of European Agency of Health and Safety at Work in year 2000, 10-15 percent of fatal accidents and 15-20 percent of all accidents were associated with maintenance work. Thus, maintenance is usually regarded as important to operators. They are extra exposed to the variety of hazards with potential harm to their health (Grusenmeyer, 2010). Therefore, one of the principal works of the maintenance department office ought to be to make a safe working environment with most extreme significance of safety in the manufacturing plant (Singh *et al.*, 2013). Safety in plant alludes to individual security and additional handle of safety. Personal safety is significant in the industries, but the more important factor is the process safety (Narayan, 2012). Therefore, health and safety at workplace should be everyone's concern.

4. Concluding remarks

Due to the rising competition in the global market and local markets, firms are progressively realizing the significance of effective maintenance management. This can be helpful in enhancing the market profit by improving product quality, decreasing rejection, reducing cost, increasing productivity and providing best service to the consumers. Many models such as RCM, CBM and TPM are used in the organization to solve maintenance-related problems. Successful implementation of these models involves many difficulties. This study has identified the main problems of maintenance operations in the accomplishment of efficient maintenance management organization in the manufacturing operations. These problems are lack of communication, lack of benchmarking, lack of empowerment, lack of commitment of employees towards maintenance, lack of teamwork, lack of training, lack of proper strategic planning, lack of top management support, lack of proper OEE, lack of awareness about safety and health and lack of effective performance measurement. Managers should focus on these problems effectively to obtain a positive impact of the manufacturing and maintenance operations on the performance of the industry.

Analysis and findings from the review show that lack of top management support, lack of focus on OEE and lack of strategic planning and implementation are the most common problems of maintenance operations and manufacturing operations in effective maintenance and production management. Although lack of benchmarking is ranked lower than the other problems, it cannot be fully ignored. These problems can only be reduced by the will and a powerful leadership which really wants to construct a quality-oriented culture in the industry. These findings will help management to formulate maintenance and manufacturing strategies. Be that as it may, before summing up these findings, some observational and contextual investigations might be completed as a future extent of the study.

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Corresponding author
Sandeep Phogat can be contacted at: sphogat@ggn.amity.edu