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Continuous Improvement through an Integrated Maintenance Model

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Abstract

The 21st century has shown intense worldwide competition in order to ensure customer requirements are met. Since the 1980s, many companies have embarked on some quality initiatives in order to increase competitiveness. This situation has arisen from different quality techniques such as total quality management (TQM), just-in-time (JIT), Six Sigma, total productive maintenance (TPM) and so on. Amongst the different approaches TPM and Six Sigma are significant business strategies that impact directly on manufacturing performance and continuous improvement. Identifying the key attributes of Six Sigma and TPM practices allow organizations to be excellent in supporting their strategy. This paper considers the integration of TPM and Six Sigma and has proposed an integrated model of TPM and Six Sigma on manufacturing performance. The main objective of this study is to identify the critical success factors of Six Sigma and TPM practices through the conceptual model in order to achieve organizational effectiveness and productivity. Additionally, it integrates the common factors of TPM and Six Sigma to gain continuous improvement. The critical success factors for continuous improvement through TPM and Six Sigma integrated model are derived on the basis of practical aspects acquired from this study. This study emphasizes on the importance of maintenance in continuous improvement.

Keywords: Continuous Improvement, Six Sigma, Total Productive Maintenance, Integrated Model

1. Introduction

Nowadays, many organizations are undergoing a lot of pressure due to higher level of customer requirements. They use supporting function to progress

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their activities. Maintenance as a significant part of activities impacts on organizational performance [1]. To respond to this major issue in manufacturing systems, Japanese companies have implemented and developed the concept of total productive maintenance. It creates a cooperative relationship between all organizational activities towards continuous improvement. Similarly, manufacturing efficiency is controlled by the extent of its ability to follow procedures and implement them [2].
Initially, TPM links the lean attitude to reduce the waste and increasing productivity of machine and equipments [3]. Therefore, the employment of complementary approach can help organizations to minimize breakdowns. Six-Sigma similar to TPM improves productivity and effectiveness [4]. These two approaches formalize the basic activities in organizations to achieve performance benefits.

Every strategy has potential advantages and each one can generate substantial performance improvement. Indeed, the different strategies overlap each other because they have some weaknesses and strengths. An integrated model usually starts from a baseline and develops from there onwards. This paper provides a detailed explanation about lean maintenance based on TPM and Six Sigma conceptual integrated model. In the proposed model, critical success factors are the baseline. TPM emphasizes on sharing responsibilities among employees and overall equipment effectiveness. Six-Sigma is an approach to reach continuous improvement. TPM and Six Sigma are the push for quality in processes, customer requirements and teamwork activities. They find opportunities and complement the maintainable continuous improvement.

2. A Review of TPM and Six-Sigma

2.1. Objectives of TPM and Six-Sigma

The purpose of TPM is to generate a strong relationship between maintenance employees and other employees in organizations in order to keep machines and equipments running and also to optimize the organizational overall performance [5]. TPM is a people oriented strategy that concentrates on improving equipment effectiveness and removing breakdowns [6]. Moreover, TPM can eliminate the wastes that create through the six major losses in companies. Failures embrace the losses such as breakdown, set up, stoppage, decreased speed, defects and reworks and start up. The safer environment is resulted from controlling these six losses [7, 8].

On the other hand, Six Sigma is a managerial approach to improve the processes of products and services in order to increase continuous improvement and decrease defects in organizations [9]. The aim of improvement process is to remove the origin reasons of performance defects in processes that previously are present in the organizations [10].

2.2 Critical Success Factors in TPM and Six Sigma Implementation

The role of top management is one of the most important factors in TPM implementation. Management commitment and support are necessary for fundamental improvement in organizations [7, 11, 12, 13, 14, 15, 16]. During recent years, authors have investigated around the critical success factors for any approach. However, TPM and Six Sigma as two key strategies influence to increase organizational outputs. Some common factors of these two tools were studied by some researchers are shown in Table 1.

Harsej *et al.*[17] emphasized on the effort of human resource from top managers to shop floor employees with attention to the practical factors such as motivation, training, benchmarking, empowerment, time allocation and competition in order to submission of continuous improvement process.

Table 1 Common critical success factors of TPM and Six Sigma

Critical Success Factors	TPM	Six Sigma
Management Commitment	Cooke, [5]; Van der Wal and Lynn [8]; Ahmed *et al.* [13]; Ahuja and Khamba [16]; Senderson *et al.* [18]; Bamber *et al.* [19].	Henderson and Evans [33]; Harry and Schroeder [34]; Eckes [35]; Schroeder *et al.* [36]; Coronado and Antony [37]; Raisinghani [38].
Employee Involvement	Bamber *et al.* [19]; Naguib [20]; Blanchard [21]; Al-Hassan *et al.*[22]; Zhu *et al.* [23]; Burhanuddin [24]; Arca and Prado[25].	Henderson and Evans [33]; Harry and Schroeder [34]; Antony [39].
Education and Training	Sun *et al.* [12]; Ahmed *et al.*[13]; Ahuja and Khamba [16]; Ravishankar *et al.* [26]; Ireland and Dale [27]; Eti *et al.* [28].	Antony [39]; Antony and Desai [40]; Pande *et al.* [41]; Hendricks and Kelbaugh [42].
Organization Structure	Ahuja and Khamba [14]; Ahuja and Khamba [16]; Bamber *et al.* [19]; Naguib [20]; Bohoris *et al.* [29].	Henderson and Evans [33]; Eckes [35]; Dale [43].
Manufacturing Strategy	Naguib [20]; Al-Hassan *et al.* [22]; Burhanuddin [24]; Arca and Prado [25]; Fredendall *et al.* [30]; Ben-Daya [31].	Harry and Schroeder [34]; Eckes [35]; Pande *et al.* [41]; Dale [43]; Gabor [44].
Responsibility	Cooke [5]; Ahuja and Khamba [14]; Naguib [20]; Al-Hassan *et al.* [22]; Ben-Day [31]; MacKone *et al.* [32].	Antony [39]; Antony and Desai [40]; Pande *et al.* [41].
Teamwork	Ahuja and Khamba [14]; Ahuja and Khamba [16]; Senderson *et al.*[18]; Bamber *et al.* [19]; Naguib [20]; Bohoris *et al.* [29].	Antony [39]; Antony and Desai [40]; Pande *et al.* [41].

As shown in table 1 both the Six Sigma and TPM program or any initiative cannot endure to succeed without commitment and support of top management. In fact, every program in organizations such as designing, programming, team forming, responsibility contributing, training should support by senior executives. Employee involvement as another key factor makes people to feel an important section of the plan. Moreover, total number of people need to train for achieving the main target of executive approach. On the other hand, a good organizational structure and manufacturing strategy are two management tools that track increasing results of completed programs. Teamwork plan is next key factor that leads organizations to propagate information feedback for gaining best results. More important, during the overall employee contribution, it is significant any employee adopts the philosophy of methods and be responsible for conducting the defined activities.

3. Need for Lean Maintenance – Proposed Integrated Model

Previously, maintenance department has been checked the set of abnormal activities in the organizations [45]. Maintenance preserves the organizational effectiveness factors such as quality, cost, employee and customer satisfaction and creates a productive system also. More importantly, the quality of maintenance impacts on profitability of organizations [28]. It is one of the big losses if it isn't considered as a critical attribute to ensure profit [46].

Lean maintenance comes from doing right activity by right employee and removing non-productive time through elimination of non-productive task [47]. Notwithstanding, lean manufacturing as a popular strategy is considered for improving productivity in many organizations, but achieving the business profitability is a difficult process still [48, 17]. In brief, TPM activities can improve manufacturing performance and increase continuous improvement [49]. Hence, TPM and Six Sigma focus on common identification and elimination inefficient procedure and performance cycle time and quality defects in manufacturing and processes.

TPM is conducted by all people through team-working activities. All trained employees acquire the skill and knowledge relevant the maintenance program within the small group functions. As researchers [22, 28] previously proved TPM can increase the efficiency of Six Sigma program. Then combination of these two programs is the way towards lean manufacturing. In addition, Cua *et al.*, [50] asserted the integrated manufacturing approach can help organizations to reach the world class level. They examined Just in Time (JIT), Total Quality Management (TQM) and TPM programs in an integrated model. They identified the conceptual and practical evidences on manufacturing area to represent improvement strategies. To conclude, they believed the combination of lean, Six Sigma and lean Six Sigma provide the different work environment to internalize continuous improvement in organizations. In another study, Simoes *et al.* [51] via investigation of about 140 studies around the maintenance area emphasized that overall organizational performance relate to the maintenance performance and efforts. So, an integrated manufacturing practice is a confident tool to solidify all programs in organization in order to promote the organizational outputs.

Hence, in this paper, the authors seek to clarify the relationship of TPM and Six Sigma that are simultaneously implemented within manufacturing systems. Figure 1 shows the aspects of integrated model to obtain continuous improvement in manufacturing environments. Whereas, Six Sigma and TPM are two strong philosophies that influence on overall organizational practices, this research considers the common critical success factors of two approaches so that achieving productivity, employee, process and products development and also continuous improvement.

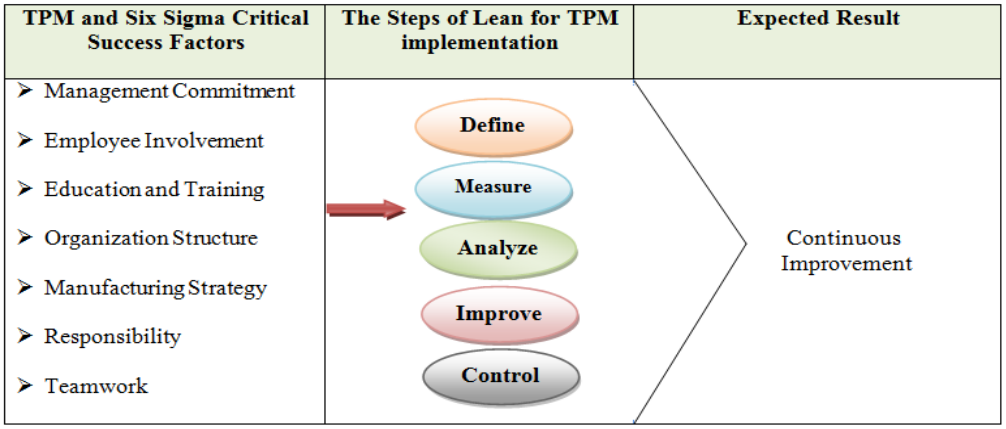

Figure 1 Integrated Maintenance Model through TPM and Six Sigma Implementation

Specifically, in Figure 1 has shown TPM and Six Sigma inside a single conceptual model. Thus, there is some core attributes of these two programs. Based on Table 1, the identified common critical factors include management commitment, employee involvement, education and training, organization structure, manufacturing strategy, responsibility and teamwork. It is structured in five phases in order to reach continuous improvement.

In the lean steps of model, the structure of maintenance investigates and evaluates in order to design main contributing factors. In define phase, significance of equipment and machine situation are recognized. Based on risk failures, the problem, its scope and process capacity are defined. It is clear that all critical factors in Figure 1 impact directly on definition and recognition of real problem in maintenance system towards higher quality. In measure phase, gathering data is conducted to analyze for next step. Here, it is also highlighted the role of each identified critical factors to achieve the real data and information regarding optimization of maintenance system. Besides, to create improvement in organizations, it is necessary to report all occurrences and events for obtaining the meaningful improvement. Therefore, investigating the changes in performance, demonstrating the solution effectiveness and evaluating the results can help to improve the process outcomes. Finally, if the organizational process is improved, it is significant that the generated improvement is maintained. Meanwhile, control phase shifts on performance to remove all practices that create defects in manufacturing systems. However, the stages of Six Sigma (DMAIC) approach, with TPM, are effective for solving the diverse issues in organizations.

4. Conclusion

The need to develop an integrated maintenance model in organizations can contribute the manufacturing performance improvement. On the other hand, due to intense competition in global business, any approach alone cannot provide a

fast solution rather it needs to change in strategy, structure and culture in order to imbibe the organizational objectives from implementation a new approach.

Based on this study, it is seemed the importance of maintenance management is clear for any organization but identifying the critical success factors and employment of the correct strategy can proportionate managerial tools with high level productivity. The use of lean steps and employment of practical factors is explicitly to provide competitive advantages inside organizations. Considering to the critical success factors improves the manufacturing performance and achieves continuous improvement. The proposed model using a structured lean steps (DMAIC) technique certainly provide basis of improvement in organizations. The application of the proposed model will allow the companies to improvement progressive systems and analysis methods and to become more specialized towards problem solving and customer satisfaction. This research only focuses on common critical success factors in TPM and Six Sigma approaches in maintenance activities. Future research will attempt to examine the impact of critical success factors on manufacturing performance.

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