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Small and Medium Enterprises enhancement through TPM and TQM

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Table of contents

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Abstract

Purpose - Total Productive Maintenance (TPM) and Total Quality Management (TQM) are proved to be innovative improvement programs, mostly in industrial environments, that can increase companies' benefits by applying them individually or in an integrated way. Small and Medium Enterprises (SMEs) are generally threatened in terms of competitiveness by quality issues and overall performance, whereas TPM & TQM are a possibility to solve them. The purpose of this paper is to propose a model to explain how TPM and TQM can affect SMEs and determine which are the practices that can improve their results.

Methodology – This is a conceptual study and the methodology applied has been the content analysis by reviewing existing literature to analyze the specific and common practices of TPM and TQM related to SMEs.

Results – Besides confirming conceptually the validity of the improvement practices from TPM and TQM for the case of Small and Medium Enterprises, other practices are proposed as critical for a successful integrated implementation of both programs.

Contribution – To propose a model that assures a successful implementation of TPM integrated with TQM including practices that were not proposed previously.

Keywords - Total Productive Maintenance, Total Quality Management, Small and Medium Enterprises

1. Introduction

Improvement programs, such as Total Quality Management (TQM) and Total Productive Maintenance (TPM), are now playing a key role in World Class Manufactures, as they seem to be the ideal tools to boost factories' performance (Ahuja and Khamba, 2008; Attri et al., 2012; Kaur et al., 2012; Singh and Singh Ahuja, 2014). Developed and applied for more than fifty years in Japan, this methodologies started to thrive in the western culture in the late 80's, having almost a period of twenty years to settle in the manufacturing collective (Dahlgaard-Park, 2011).

Nowadays, almost every successful factory, especially from multinational companies, has implemented one or more improvement systems as a guideline for their processes and businesses. Although other frameworks have emerged, like Lean Manufacturing and Six Sigma, TQM and TPM seem to have a wider scope, and may have stated the basis for these other methodologies (Sila, 2007; Dahlgaard-Park, 2011). The outcomes of both of them can be sorted in three groups:

- the common ones, like cost reduction, increase of productivity and employee satisfaction (Sila, 2007; Singh and Singh Ahuja, 2014),

- the TQM outcomes like customer satisfaction, customer loyalty and product innovation (Sila, 2007; Modgil and Sharma, 2016),

- the TPM outcomes like unexpected breakdown reduction, accidents reduction and delivery performance (Kaur et al., 2012; Singh and Singh Ahuja, 2014; Jain and Bhatti, 2015).

There is vast literature posing the benefits of either the implementation of Total Productive Maintenance (TPM) and Total Quality Management (TQM) in an integrated way or by implementing at least one of these methodologies or practices (Attri et al., 2012 ;Cua et al., 2001; Dora et al., 2012; Kaur et al., 2012; Konecny and Thun, 2011; Modgil and Sharma, 2016).

A large majority of previous studies could prove a positive relationship between improvement programs and business, achieving results where more than a 70% of the companies that apply these practices could evidence this success (Sila, 2007; Foon and Terziovski, 2014). This can be easily explained through their foundations: the "soft" practices such as human resources-oriented practices and the ones that tend to make

the organizational culture to grow, and the performance outcomes and “hard” practices, which are mainly related to technical tools (Sila, 2007; Foon and Terziovski, 2014).

Something that characterize most of the research about TPM and TQM is that almost every author recognizes the need for companies to remain competitive (McKone et al., 1998; Konecny and Thun, 2011; Attri et al., 2012; Kumar Sharma and Gopal Sharma, 2013; Kaur et al., 2012). This fierce competition affects particularly to Small and Medium Enterprises (SMEs) which are forced to improve their performance in order to remain competitive against larger enterprises (Singh et al., 2010; Kumar Sharma and Gopal Sharma, 2013; Jain and Bhatti, 2015). In this sense, they need to improve product quality, reduce costs and upgrade their technology. As TPM and TQM were created and designed to improve several aspects of manufacturing companies, such as overall performance (or OEE- overall equipment efficiency), quality issues, cost reduction and maintenance reliability (McKone et al., 1998; Foon and Terziovski, 2014), they perfectly fit in the needs of SMEs.

Taking the abovementioned into account, the purpose of this paper is to propose a model to explain how TPM and TQM can affect SMEs and determine which are the practices that can improve their results.

The paper is structured as the following: next literature review where TQM and TPM are defined and characterized, common practices found in them, OEE as a performance metric, and the relationship between SMEs and the improvement programs. Then, the methodology used is described, followed by the results where a set of propositions is suggested with a proposed model. Finally, the conclusions are presented, along with the managerial and academic implications, the limitations and future research.

2. Literature Review

The available literature about Total Productive Maintenance (TPM) combined with Total Quality Management (TQM) has been largely discussed (Konecny and Thun, 2011; McKone et al., 1998), and a certain difficulty arises when trying to link these two concepts with Small and Medium Enterprises (Salaheldin, 2009; Dora et al., 2012).

Before defining each term, it is important to note that there is no a single and standardized definition. Instead, each definition varies from company to company, and because of this, many academics have proposed their own (Dahlgaard-Park, 2011).

First, both practices are presented individually, then related and finally two important aspects are also presented: OEE and SMEs.

2.1 Total Quality Management (TQM)

TQM can be understood both as a program and a philosophy that aims to improve performance from quality (Konecny and Thun, 2011; Modgil and Sharma, 2016, and Singh Ahuja, 2014) through the entire value chain (Kaur et al., 2012), by offering greater value to customers by identifying their needs and desires (Singh and Singh Ahuja, 2014).

TQM is involves a wide branch of perspectives and practices, that started as a technical approach, and that can also cover organizational aspects (Moreno Luzón and Valls Pasola, 2011). This scope can also be classified in soft and hard aspects: the soft ones are related to the social and human aspects, while the hard one with the technical orientation (Calvo Mora et al., 2014).

Previous research conducted by Sila (2007) grouped the main practices of TQM in seven categories with a brief description:

(1) Leadership: Top manager and supervisor level has to be committed and take leadership. This counts not only for the organizational behavior, but also for public responsibility and citizenship.

(2) Strategic planning: Three things have to be clearly defined, the quality mission, the goals and the policy. This has to be assisted with a strategy development and its respective deployment.

(3) Customer focus: customer and market knowledge becomes essential, the company has to attend the customer satisfaction by implementing the customer relationship management.

(4) Information and analysis: Performance needs to be measure in order to be managed properly. Quality analysis is introduced, as well as the benchmarking.

(5) Human resources management: Related to every aspect of the employees, it involves employee involvement, empowerment, teambuilding and training.

(6) Process management: related to product design, statistical process control and continuous improvement.

(7) Supplier management: In order to produce quality, suppliers need to deliver quality, based on quality involvement and supplier relationships.

TQM has also been related to other management systems as it is mentioned by Sila (2007) because of the reach of its principles: it can facilitate the implementation of ISO 9.001 and other World Class practices like TPM, Six Sigma and Lean Manufacturing.

2.2 Total Productive Maintenance (TPM)

On the other hand, TPM more than a philosophy is an improvement program (Bamber et al., 1999), based on productive-maintenance activities followed by the total workforce that promotes the increase of productivity by preventing machines failures and breakdowns (Attri et al., 2012; Kaur et al., 2012; Konecny and Thun, 2011). The most discussed practices are the autonomous maintenance, equipment or technical emphasis and team based maintenance (Cua et al., 2001; Konecny and Thun, 2011; Bartz et al., 2014).

TPM was conceived on the basis of 8 pillars (Bartz et al., 2014; Sivaram et al., 2014; Jain and Bhatti, 2015): autonomous maintenance, planned maintenance, focused improvement, quality maintenance, education and training, safety and environment, office TPM and development maintenance. They are all describe below;

(1) The autonomous maintenance expresses the need for every person in the company to be committed with the program, with a particular case for the production team, who are responsible for the daily maintenance activities, such as cleaning, lubricating and performing minor inspections or adjustments. These three activities are called the basic condition of operation and maintenance (Bartz et al., 2014; Sivaram et al., 2014; Jain and Bhatti, 2015).

(2) The planned maintenance is identified as a strategic role surrounded by the increasing complexity of technology, and also because maintenance-related costs can take predominance (Singh and Singh Ahuja, 2014; Jain and Bhatti, 2015). The way to deploy this activity varies from industry to industry, but it is based on applying different preventive and predictive techniques through planned activities, contrary to the most common practice of corrective intervention (Bartz et al., 2014; Sivaram et al., 2014).

(3) Focused improvement is the most related pillar with the term “continuous improvement”, and it can be summarized as the systematic identification and treatment of losses, with a main objective: to improve efficiency (Sivaram et al., 2014).

(4) Quality maintenance is a particular pillar, since many authors posed that TQM and TPM are closely related (McKone et al., 1998; Foon and Terziovski, 2014; Singh and Singh Ahuja, 2014; Modgil and Sharma, 2016). Basically, it is about focusing efforts on obtaining zero defects by analyzing the relationship between equipment and the root cause of defects, and setting control parameters (Bartz et al., 2014; Sivaram et al., 2014).

(5) The education and training is commonly related in literature with the significance of employee empowerment (Cua et al., 2001; Hansson and Backlund, 2003; Ahuja and Khamba, 2008; Konecny and Thun, 2011; Foon and Terziovski, 2014; Singh and Singh Ahuja, 2014; Poduval et al., 2015). For this it is key to deploy a deep training program, where employees get trained in technical issues, develop their skills and knowledge, and to align employee’s with the organization’s goals (Sivaram et al., 2014).

(6) The safety and environment pillar aims to ensure a safe working place, both for the employee and for the environment (Bartz et al., 2014; Sivaram et al., 2014).

(7) A less developed point, but not least important, is the office TPM, where synergy should be achieved to integrate different organizational functions, reducing procedural bureaucracy and focusing on cost reduction (Ahuja and Khamba, 2008; Sivaram et al., 2014).

(8) The last pillar, the development maintenance, is related to the conception of new projects and how to minimize problems in their launching (Ahuja and Khamba, 2008).

The activities are grouped this way in order to organize the companies’ strategy with the goal of achieving three key performance indicators: zero defects, zero breakdowns and zero accidents. Through this three measures, this program understands that this is the way to achieve a better performance in terms of efficiency, losses and waste reduction, quality and flexibility. The alignment of these pillars with the three “zero’s” is done with the implication of each of them.

It is common to find in literature about TPM several case studies, like the ones performed by Bamber et al., (1999), Kumar Sharma and Gopal Sharma, (2013), or Jain and Bhatti, (2015). What they have in common is a proposal for testing different models according to each case, like a 6 steps program for the UK automotive industry (Bamber

et al., 1999), a framework that relates TPM with other improvement methodologies like Six Sigma in an Indian paper manufacturer, or a traditional TPM model where the concept of “mobile maintenance” is introduced in an Indian oil company.

Others simply focus on more general issues, like identifying barriers (Attri et al., 2012), explaining the synergy between TPM and other improvement programs (Konecny and Thun, 2011) or testing the impact of TPM on operational performance (Modgil and Sharma, 2016).

Regarding to the size of the company, the majority of them involves large companies, or a mixed sample, with a notorious lack of SMEs in the samples (Dora et al., 2012).

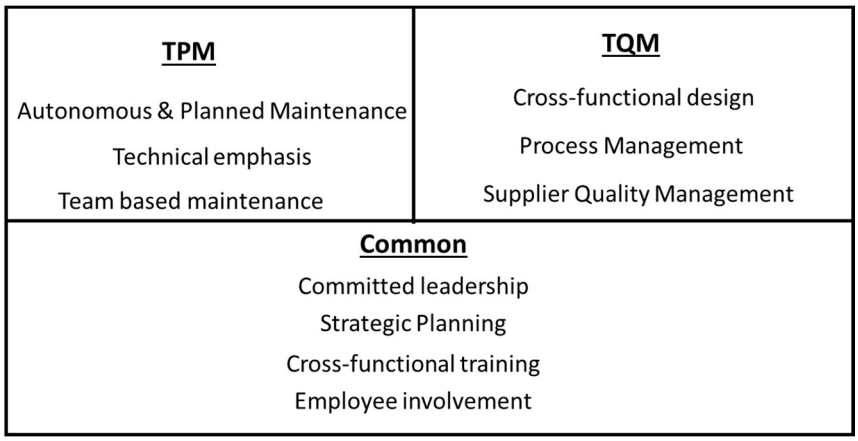
2.3 Common practices of TQM and TPM

There are also common practices to TPM and TQM that are easily identified in previous research, such as committed leadership, cross functional training and employee involvement and strategic planning (Cua et al., 2001; Konecny and Thun, 2011). This again reaffirms the close relationship between both programs. The first three involve the employee recognition and its consequent motivation, while the strategic planning is about setting the priorities for achieving the goals through the company mission and vision (Hansson and Backlund, 2003). Nevertheless, the focus of each program has slightly differences, as TPM is more oriented to shop floor operations and TQM is more related to strategic management (Modgil and Sharma, 2016).

This combination can gain synergy to support both orientations, quality for the case of TQM, and maintenance for TPM, and also can be used as an operational control tool (Wang and Lee, 2001). It is also important to mention that the common practices also share a relationship regarding to the success or failure of the implementation, since these practices were proved to be fundamental when implementing any of the programs (Cua et al., 2001).

Nowadays, the benefits that these two programs can contribute are very well-known as previous research has covered both individually (Attri et al., 2012; Cua et al., 2001) and integrally (Dora et al., 2012). In order to summarize it, figure 1 shows the specific techniques and tools for TPM and TQM, and the common ones, based on Cua et al. (2001)’s and Konecny and Thun (2011)’s previous research.

Figure 1 - Specific and common techniques and tools



Source: Cua et al. (2001) and Konecny and Thun (2011)

2.4 Overall Equipment Efficiency (OEE)

As it was mentioned previously, one of the key indicators used when applying TPM and TQM is the Overall Equipment Efficiency, or OEE, which is a metric used to evaluate performance. It is calculated by the product of three factors: availability, performance efficiency, and rate of quality (Wang and Lee, 2001; Ahuja and Khamba, 2008; Kumar Sharma and Gopal Sharma, 2013; Sivaram et al., 2014). Availability is defined as the available time of production, usually decreased because of breakdown losses and set-up and adjustment losses, performance efficiency can be understood as the number of produced items in a giving period of time, and rate of quality is the relationship between accepted items and total produced items (Kumar Sharma and Gopal Sharma, 2013).

In order to be able to know how good a company is performing, there is a criterion to follow, known as World Class Manufacturing index or WCM, where an OEE of 85% is a demanding goal to achieve (Wang and Lee, 2001; Ahuja and Khamba, 2008; Kumar Sharma and Gopal Sharma, 2013; Sivaram et al., 2014). This scale comes from years of gathering data from manufacturing companies, and is the result of a 90% of availability, 95% of performance efficiency, and 99% Quality rate.

Taking as an example the case study of Kumar Sharma and Gopal Sharma, (2013), where TPM was implemented along with Six Sigma, it is easy to see how OEE can be boosted:

In the starting year, the plant reported 82% of availability, where 18% of the time the plant was not able to produce due to hydraulic and mechanical failures. The efficiency was 80%, meaning that a 20% of the production was lost because of reduction on the machines speed. The quality rate was 75,1%, with 24,9% of the production rejected because of wrinkles and high cob. With these parameters OEE can be calculated as follows:

$$\text{OEE} = \text{Availability} \times \text{Performance efficiency} \times \text{Quality Rate}$$

$$\text{OEE} = 82\% \times 80\% \times 75{,}1\% = 49{,}26\%$$

After the implementation, the availability increased to 91%, Performance efficiency to 90,5%, and the Quality rate to 95%. With these new values, OEE was:

$$\text{OEE} = 91\% \times 90{,}5\% \times 95\% = 78{,}23\%$$

This final OEE is much closer to the WCM suggested mark, meaning an improvement of 58%.

2.5. Small and Medium Enterprises (SMEs) related to TPM and TQM

Referring to Small and Medium Enterprises (SMEs), they can represent up to 80 percent of the economic growth (Singh et al., 2010), for what it may be interesting to analyze how they can improve their performance. In order to do this, it is important to understand how they are affected, and competitiveness is the concept that best explains it (Jain and Bhatti, 2015; Kumar Sharma and Gopal Sharma, 2013; Singh et al., 2010). Since SMEs act as a key member of larger companies' supply chain, specifically as suppliers of components, parts and sub-assemblies, the impact their performance has can affect directly to these larger companies (Ghobadian and Gallear, 1996). Two aspects are considered to be the main drivers of competitiveness: quality performance and cost reduction, with the implication that remaining as low cost suppliers ensures them continuity in the market, especially in a global and competitive economy (Ghobadian and Gallear, 1996; Jain and Bhatti, 2015; Singh et al., 2010).

SMEs also differ from large companies over the reasons for why they implement improvement programs. One of the main reasons for large companies is due to corporate

decisions, while in the case of SMEs is a matter of necessity, with the goal to accomplish the customer requirements (Sila, 2007).

Although there is literature that states that practices like TPM and TQM are more likely to be found in larger companies, among the different improvement practices, TPM has reported to be the one with best uptake in SMEs (Dora et al., 2012). Having this in mind, it would be wise to integrate TPM with TQM, as much of the literature exposes to enlarge the performance outcome (Cua et al., 2001; Kaur et al., 2012; Konecny and Thun, 2011; Kumar Sharma and Gopal Sharma, 2013).

Table 1 displays the literature found with the methodology criteria, classifying it according to the size of the respective company and the improvement program. 25 studies were analyzed.

From the seven papers about SMEs, three of them pose the importance of practices related to reduce times of set-up, two of them emphasize the predictive maintenance, only one deals with the metrics analysis, and only one exposes organizational culture in a general manner.

Table 1 –Specific and common practices found on the content analysis

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Ghobadian and Gallear (1996)	SME	TQM		Process Management, Supplier Quality Management	Committed leadership, Cross-functional training, Employee involvement	
McKone et al.(1998)	Mixed	Integrated	Autonomous and Planned Maintenance	Cross functional design, Process Management	Cross Functional Training, Employee Involvement	
Bamber et al. (1999)	SME	TPM			Committed leadership, Strategic Planning, Employee Involvement	Organizational culture
Cua et al. (2001)	Mixed	Integrated	Autonomous and Planned Maintenance, Technical emphasis, Team based activities	Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Strategic Planning, Cross Functional Training, Employee Involvement	

Table 1 – (continued)

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Wang and Lee (2001)	Mixed	Integrated	Autonomous and Planned Maintenance, Technical emphasis, Team based activities		Committed leadership, Strategic Planning, Cross Functional Training, Employee Involvement	
Hansson and Backlund (2003)	Mixed	Integrated	Team based activities	Process Management	Committed leadership, Strategic Planning, Cross Functional Training, Employee Involvement	
Sila (2007)	Mixed	TQM		Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Strategic Planning	
Ahuja and Khamba (2008)	Large	TPM	Autonomous and Planned Maintenance		Committed leadership, Cross Functional Training	
Salaheldin (2009)	SME	TQM		Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Cross Functional Training, Employee Involvement	Metrics analysis

Table 1 – (continued)

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Singh et al. (2010)	SME	TPM	Autonomous and Planned Maintenance, Technical emphasis	Supplier Quality Management		Set-up times
Dahlgaard-Park (2011)	Large	Integrated		Process Management, Supplier Quality Management	Strategic Planning	
Konecny and Thun (2011)	Large	Integrated	Autonomous and Planned Maintenance, Technical emphasis, Team based activities	Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Strategic Planning, Cross Functional Training, Employee Involvement	
Moreno Luzón and Valls Pasola (2011)	Mixed	TQM		Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Cross Functional Training, Employee Involvement	

Table 1 – (continued)

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Attri et al. (2012)	Mixed	TPM			Employee involvement, cross functional training	
Dora et al. (2012)	SME	Other		Process Management	Employee involvement, Cross Functional Training	Set-up times
Kaur et al. (2012)	Mixed	Integrated	Autonomous and Planned Maintenance, Technical emphasis, Team based activities	Cross functional design, Process Management, Supplier Quality Management	Strategic Planning, Cross Functional Training, Employee Involvement	
Kumar Sharma and Gopal Sharma (2013)	SME	Other	Autonomous and Planned Maintenance, Technical emphasis, Team based activities		Committed leadership, Cross Functional Training, Employee Involvement	Preventive and predictive Maintenance, Set-up times

Table 1 – (continued)

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Bartz et al. (2014)	Large	TPM	Autonomous and Planned Maintenance, Team based activities		Cross Functional Training, Employee Involvement	
Calvo Mora et al. (2014)	Mixed	TQM		Process Management, Supplier Quality Management	Committed leadership	
Foon and Terziovski (2014)	Mixed	Integrated	Autonomous and Planned Maintenance, Technical emphasis, Team based activities	Cross functional design, Process Management, Supplier Quality Management	Committed leadership, Strategic Planning, Cross Functional Training	
Singh and Singh Ahuja (2014)	Large	Integrated	Autonomous and Planned Maintenance		Committed leadership, Cross Functional Training, Employee Involvement	

Table 1 – (continued)

Author/s (publication year)	Size of company (SME, large or mixed)	Improvement program (TPM, TQM, Integrated, Other)	TPM Practices	TQM Practices	Common Practices	Suggested practice for SEM
Sivaram et al. (2014)	Large	TPM	Autonomous and Planned Maintenance	Process Management	Cross Functional Training	
Jain and Bhatti (2015)	SME	TPM	Autonomous and Planned Maintenance, Technical emphasis, Team based activities		Committed leadership, Cross Functional Training, Employee involvement	Preventive Maintenance
Poduval et al. (2015)	Large	TPM	Autonomous and Planned Maintenance, Team based activities	Cross functional design	Committed leadership, Cross Functional Training, Employee Involvement	
Modgil and Sharma (2016)	Large	Integrated	Autonomous and Planned Maintenance, Technical emphasis	Cross functional design	Cross Functional Training, Employee Involvement	

Source: Own elaboration

Based on the analyzed literature, table 2 was developed by classifying the size of company and the improvement program.

Table 2 – Improvement programs and the size of the company

	TPM	TQM	Integrated	Other	**Total**
SME	3	2	0	2	**7**
Mixed	1	3	6	0	**10**
Large	4	0	4	0	**8**
Total	**8**	**5**	**10**	**2**	**25**

Source: Own elaboration

The above review can give a glance of what can be found in literature. Most of the research is based on medium and large size companies, and very few on SMEs (Salaheldin, 2009; Dora et al., 2012). Also, it is remarkable that integrated programs are very common (Konecny and Thun, 2011; McKone et al., 1998). It is even possible to find other kinds of programs combined with TPM or TQM, such as Six Sigma and Lean Management (Sila, 2007; Dahlgaard-Park, 2011).

This table is a clear example that further research is still needed to link SMEs with the integration of TPM and TQM.

3. Methodology

This research follows a content analysis methodology, based on what Flynn et al. (1990) stated about research in operations management: The systematic compilation of management practices helps to shed light on current trends, to build new theories and to state relationships between practices and businesses outcomes. As it was shown in table 2, the lack of information about SMEs applying TPM and TQM fits with the need to develop a theory that lays the foundations of a new concept.

The reviewing process was performed using Scopus, Emerald and Web of Science, using the following keywords: Total Productive Maintenance, Total Quality Management, and Small and Medium Enterprises.

The filtering process included English language, article document type, journals source type and a basic pre-analysis to determine the relationship between the articles and the research.

4. Results

The results are presented according to the objective of this research by proposing a model to explain how TPM and TQM can affect SMEs and determine which are the practices that can improve their results.

In order to present and justify the proposed model, 4 different propositions are posed.

The first proposition tries to explain the direct relationship between SMEs and positive outcomes because of the implementation of TPM. It was proposed in previous research regarding to large companies or even in mixed samples (McKone et al., 1998; Wang and Lee, 2001). Nevertheless, previous empirical research exposes that SMEs can implement TPM successfully as any large company (Wang and Lee, 2001). Thus:

Proposition 1: TPM has as positive impact on SMEs

Sila (2007) proposed a comparison between different organizational characteristics, based on a divided stance between previous research that stated that the implementation of TQM would be different for large and for small and medium companies. Results showed that there was not enough evidence to confirm it, concluding that the size of a company is not a determinant. In the model, it is expected that the impact would be positive:

Proposition 2: TQM has as positive impact on SMEs

On the other side, research could be found with evidence posing the benefits of the integration of both programs, but again, without taking into account the particular case of SMEs (Wang and Lee, 2001; Hansson and Backlund, 2003; Dahlgaard-Park, 2011; Konecny and Thun, 2011; Kaur et al., 2012; Foon and Terziovski, 2014; Singh and Singh Ahuja, 2014; Modgil and Sharma, 2016). Thus, the third proposition is presented:

Proposition 3: TPM integrated with TQM have a greater impact on SMEs rather than individually

The last proposition has the intention to shed light on differentiating how SMEs can adopt certain practices that best fit to their operations, understanding that their needs and resources are going to be different from large companies (Dora et al., 2012).

From the content analysis, some of the practices proposed by Cua et al. (2001) and Konecny and Thun (2001) come up recurrently. In the case of TPM practices, the three of them, Autonomous and Planned Maintenance, technical emphasis and team based activities, can be found in other research (Wang and Lee, 2001; Singh et al., 2010; Kaur et al., 2012; Foon and Terziovski, 2014). Regarding to TQM practices, only supplier quality management and process management seem to have an outcome (Dahlgaard-Park, 2011; Kaur et al., 2012; Calvo Mora et al., 2014). For the common practices, employee involvement turned out as the most cited, followed by both committed leadership and cross functional training (Bamber et al., 1999; Singh et al., 2010; Dora et al., 2012; Kumar Sharma and Gopal Sharma, 2013; Jain and Bhatti, 2015).

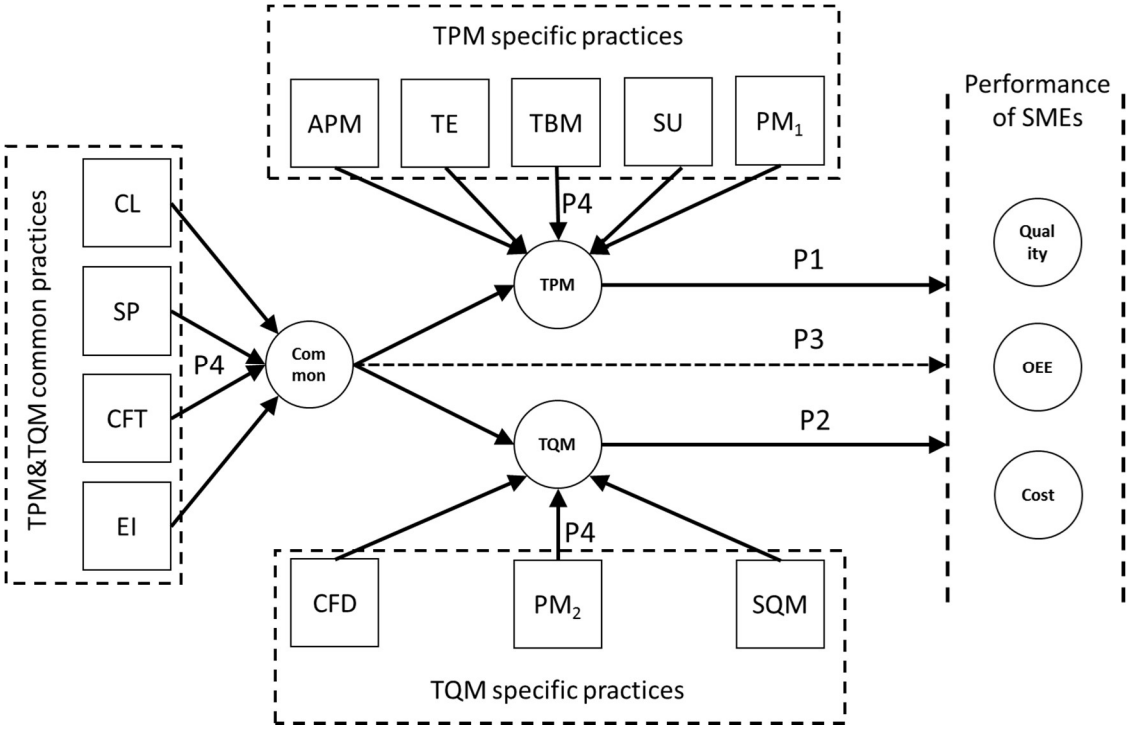
Other practices apart from the above turned up mentioned as critical for the success of SMEs applying an improvement program, in this case directly related to TPM: Set-up time reduction and preventive maintenance. High set-up times impact directly into the cost of production, and it also decreases delivery time and forces these companies to maintain a structure of big lots, compromising their competitiveness (Singh et al., 2010; Dora et al., 2012; Kumar Sharma and Gopal Sharma, 2013). Regarding to the specific preventive maintenance practice, it was identified in the literature as a key point in order to avoid maintenance costs to increase (Kumar Sharma and Gopal Sharma, 2013; Jain and Bhatti, 2015). Thus, the fourth proposition is:

Proposition 4: Certain tools and techniques can obtain bigger benefits than others

Figure 2 synthesizes these propositions, grouping in a clear way the practices that each program raises and the common practices.

In this model, propositions are also presented to clarify their relationship with the performance outcome, which are proposed to measure the performance of SMEs implementing TPM and TQM integrally, since they were identified as the critical ones to assure competitiveness.

Figure 2 – Proposed model



Source: Own elaboration adapted from Cua et al., (2001), and Konecny and Thun, (2011)

Note: TPM = Total Productive Maintenance; TQM = Total Quality Management; OEE = Overall Equipment Efficiency; APM = Autonomous and planned maintenance; TE = Technical emphasis; TBM = Team based maintenance; SU = Set-up times; PM_1 = Preventive maintenance; CFD = Cross-functional design; PM_2 = Process management; SQM = Supplier quality management; CL = Committed leadership; SP = Strategic planning; CFT = Cross-functional training; EI = Employee involvement

5. Conclusions

This research aims to clarify how SMEs can implement TPM integrally with TQM as a solution for the constant and demanding competitiveness they have to go through. The content analysis performed allow posing the following conclusions.

First, TPM practices like Autonomous and Planned Maintenance, technical emphasis and team based activities report to be the base of the implementation for every kind of company.

Secondly, for the case of TQM only Supplier Quality Management and Process Management seem to be significant practices, as it is probable that Cross Functional Design is a practice almost reserved for companies with specific R&D departments and where resources of this kind are not a problem.

Thirdly, as it is mentioned for large companies as well as for SMEs, the critical practice for the success of any improvement program is Employee involvement, followed by committed leadership and cross functional training.

At last, but no least, two practices are identified as critical for SMEs because of their effect to lowering costs: Set-up times reduction and Preventive Maintenance. The first one deals with looking after operational time and the ways to optimize productive time, keeping non-productive time at its minimum level. This time saving would mean more production on the one hand, and lower fixed costs on the other.

Finally, a Preventive Maintenance plan would entail at first an investment, specially referring to spare parts and supplies, but in a middle term would reflect its benefits by minimizing unexpected breakdowns that again compromises the valuable operational time.

The proposed model clarifies which are the practices that SMEs can adopt from the specific and common practices from TPM and TQM, to enhance their performance related to quality issues, performance efficiency (OEE) and costs, . Further, according to Proposition 4, SMEs can also identify which are the practices that best fits their needs and resources, such as the SMED practice for reducing the set-up times, or developing a Preventive maintenance program, in order to avoid unexpected failures.

This paper presents a managerial implication since it identifies the possible practices that SMEs can adopt as they were previously applied. Referring to the academic implication, it contributes by enlarging the literature, especially about the findings about the practices that be determinant for SMEs.

One of the limitations of this work may be affected by part of the literature in which is based, since, as it was mentioned in the literature review, many of the research is conducted through case studies. This cases may have singular implications, for what a wider study may guide to a more comprehensive understanding.

Further research could focus on testing empirically this model, with an especial interest on determining the significance of the Set-up time reduction and Preventive Maintenance practices, or to test and analyze possible differences with the other practices.

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