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Implications of Total Productive Maintenance in Psychological Sense of Ownership

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Abstract

Problem Statement: In a global market as we are experiencing nowadays, the search for competitive advantages over its competitors is one of the required strategies for companies that intend to survive. This way, Total Productive Maintenance (TPM) Model provides the development such as autonomous maintenance. This method resorts to different tools, in order to seek operators commitment to maintain optimal conditions for production and equipment performance. **Research Questions:** What are the implications of Total Productive Maintenance in Psychological Sense of Belonging? **Purpose of the Study:** To evaluate an operator's psychological sense of ownership in a section of a particular plant, in order to propose and encourage ways of making them able to promote high levels of productivity for the operator's work. **Research Methods:** A descriptive study conducted with a convenience sample of 30 participants living in Portugal. Psychological Sense of Ownership was assessed by the Psychological Ownership Questionnaire (Avey et al., 2009). This allows sense of belonging to be measured, providing support to the five dimensions of this feeling (self-efficacy, self-identity, owning a house, responsibility and territoriality).

Findings: The existence of a psychological sense of ownership by operators was confirmed for the factory's section areas and production lines. Both a significant and positive association for all 5 dimensions (Territoriality, Self-efficacy, Self-identity, Owning a House and Responsibility) was found, particularly for the General Warehouse and Palletizing. **Conclusions:** The implementation of TPM tools promoted the interaction of operators with the equipment, providing continual attention in detecting and anticipating anomalies resulting in the reduction of failures, breakdowns and quality defects. The existence of a culture promoting a sense of psychological ownership ensures the commitment of workers and generates increased levels of productivity.

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1. Introduction

The current behaviour of the markets requires companies to develop strategies for achieving improvements in order to remain competitive. In this context, Total Productive Maintenance (TPM) Model is an innovative approach to company maintenance that optimizes equipment efficiency, eliminates faults and promotes autonomous maintenance between operators, through day-to-day activities involving the entire force work (Nakajima et al. 1988). TPM tools are often named by Ahuja & Khamba (2008), Sharma et al. (2012) and Venkatesh (2007) as taking part of eight pillars or TPM elements called: 1- Autonomous maintenance; 2- Focused maintenance; 3- Planned maintenance; 4- Quality maintenance; 5- Education and training; 6- Safety and environment; 7- Administrative TPM; 8- Improvement management. According to Pierce et al. (2001), psychological ownership is a psychological state in which the individual feels that the target of membership (material or immaterial) or a portion of this target belongs to him. The same authors also highlight that psychological state of ownership results from a psychological connection and a sense of possession towards an object. Objects through which individuals develop possession, that become part of the individual, shaping their self-identity. So far, emerges the psychological feeling of belonging (Pierce et al., 2003). For Avey et al. (2009) these feelings are a very real phenomenon that many recognize and comment as being related to work and to organizational environment. However, ideas or personal life factors are also considered targets of this feeling. Birger (2008) shows, as an example, that often dating couples feel belonging and possession for each other referring to each other as "my / my" boyfriend / a, although none of them possesses truly the other. Pierce et al. (2003) argues that psychological ownership has a positive effect on people, reflected in a greater sense of responsibility for results at work, a greater organizational commitment, increased productivity, among others. On the other hand, there is a negative relationship between the psychological feeling of belonging and the people's turnover in the occupied functions, i.e. the sense of belonging is negatively related to consecutive swapping of functions. In a positive way, what is intended is that the psychological sense of belonging is assumed by the individual to his target of belonging. So, according to Pierce et al. (2001), with the acceptance of the target by the individual, this target becomes part of that individual's identity. The same authors state the feeling of possession is the conceptual distinction of the sense of psychological belonging of other concepts that can report a psychological relationship, because it distinguishes the belonging of feelings as organizational commitment, personal satisfaction, personal identification and involvement in work. So, according to this, it is very pertinent to understand what are the reasons or what are the roots by which exists this sense of belonging, and what are the motivations of the individual to achieve this state.

Social psychology shows that people develop positive feelings for tangible or intangible objects for which they feel belonging (Jeswani et al. 2012). Pierce et al. (2003) suggest that the feeling of belonging roots can be found in three human motives, which are self-efficacy, self-identity and "own a house". Psychological sense of belonging is seen as a way to achieve competitive advantages in the organization of work methodology because it induces workers to apply more of their efforts in the organization.

This study implemented the autonomous maintenance pillar of Total Productive Maintenance (TPM) in a yogurt filling section, working as a support to the development of a sense of ownership of the operators in this section, in order to use this feeling as a competitive advantage for it is believed that through it the performance of people, equipment and processes will be higher.

2. Problem Statement

To improve the operational status of a company, there are required strategies that aim to eliminate waste, ensure quality and reduce costs.

The approach to Total Productive Maintenance (TPM) leads to the development of methods and management tools that promote organizational change, especially at human resources level. TPM philosophy supports a culture in which the operator develops a sense of belonging towards the equipment that he handles, getting to know them better, ensures a climate of continuing efforts towards the targets of belonging, developing skills and competencies, to continually stimulate the operators action improvement (Willmott, 1994). Development of one of TPM pillars, autonomous maintenance, is at the root of these changes. In this case, through the sense of belonging, it is promoted the interest of operators for their work and performance, providing organizational advantages at all levels. Ahmed

and Siong (2007) report that TPM implementation not only improves availability and confidence in the equipment, but also provides progress and increasing in production, in product quality development and develops a team spirit culture, while it also increases work capacity among individuals. In addition to the operational performance improvement of the factory floor, there is an expansion at employees' attitudes levels. Through the productivity model, namely the autonomous maintenance, it was an aim of this study to evaluate the feeling of belonging of operators in a particular factory section, in order to make them able to endorse, in their work environment, changes to ensure high productivity levels.

The strategies adopted in this way are associated with the selection of methodologies that provide improvements in people, equipment and processes performances. Materializing this strategy, the implementation of a TPM program was set in a Portuguese company.

3. Research Question

The implementation of autonomous maintenance leads towards two fundamental issues in this study and, consequently, the consideration of two perspectives: the human perspective and the equipment perspective.

One of them is related to the operator's knowledge development promotion through their respective sections. Based on the operator's skills profile it is also important to consider how to harmonize the knowledge and the operators' sense of belonging in relation with those sections. The other issue is related to the need to continually have an organized work plan, in which any nonstandard situation must be instantly identified, trying to understand, this way, what is the sense of belonging by the equipment.

It was in this context that the overall research question emerged: What are the implications of Total Productive Maintenance in Psychological Sense of Belonging?

4. Purpose of the Study

The main goal of this study is related to the development of autonomous maintenance tools in Ercas filling section of a Portuguese company.

It was also sought to analyse the sense of belonging of the operators in the various sections of the company, evaluating if the position in the section has consequences in actions that operators develop.

Literature supports that the implementation of autonomous maintenance operations develops in individuals a sense of psychological belonging to the equipment they handle. This interaction promotes in individuals feelings of self-efficacy, self-identity, responsibility and territoriality (Pierce et al., 2001 and Avey et al., 2009).

Interest in the application of Psychological Ownership Questionnaire to measure the sense of belonging has a dual basis. On one hand it is pertinent to analyse the sense of belonging of operators to the area for which they are responsible and to the production line, admitting that there are differences between them. On the other hand, it was also intended to learn if to the pilot production line, where there was a further development in this project, there were significant differences in the sense of belonging compared to other areas.

5. Research Methods

The descriptive exploratory study was conducted among a sample of 33 operators, and the categorization by the company areas as follows: Dairy - 3 Processing - 5, Ercas - 8, Liquid - 11, Palletising - 4 and General Store - 2.

It was asked to operators of the various areas of the company to respond individual, voluntary and anonymously. It was explained to them the reason for the study, the reason and structure of the survey. The results analysis was performed according to the company lines and areas of production.

Psychological Ownership Questionnaire proposed by Avey et al. (2009) was used for evaluating the sense of belonging by providing support to these concepts and revealing the five dimensions of this feeling (self-efficacy, self-identity, "own a house", responsibility and territoriality).

The survey is divided into three sections, each of which reports to the sentiment assessment in this study towards the production line and the area in which the operator works.

It is organized in the form of Likert's Scale of 6 points, translated as following: 1 - Strongly Disagree 2 - Disagree 3 - Somewhat disagree, 4 - I agree in part 5 - I agree 6 - I totally agree. Through Cronbach's Alpha values it is possible to discern on the internal consistency of measurement instruments and taking into account the reference values of Field (2011) it is considered that: Cronbach's Alpha values / Internal Consistency: > 0.9 - Very good; > 0.8 to 0.9 - Good; > 0.7 to 0.8 - Average; > 0.6 to 0.7 - Poor; <0.6 - Inadmissible.

The psychometric study of Psychological Ownership Survey made it possible to infer the validity of the enquiry in this particular sample, showing a very good internal consistency, with the Cronbach's Alpha value swinging between 0.76 and 0.92 (Field, 2011). As for the total amount of internal consistency of the sense of belonging leaning scale, which corresponds to the agglomeration of all the dimensions of this feeling (self-efficacy, Responsibility, "Own a house" and Self-Identity), it reached a value of 0.915 that can be interpreted as a very good consistency.

According to the dimensions' internal consistency values, the following values were obtained: Territoriality was 0.86, translating a good internal consistency; Self-efficacy stood at 0.92, what is considered as very good; Responsibility reached a value of 0.78, which is considered reasonable; "Own a House" achieved 0.89 and self-identity 0.88, being both rated good.

Table 1: Cronbach's Alpha values for Psychological Questionnaire Ownership Dimensions

Dimensions	Line			Area		
	Mean	Standard deviation	Cronbach's Alpha	Average	Standard deviation	Cronbach's Alpha
Territoriality	2,15	1,52	0,81	2,10	1,43	0,86
Self-efficacy	5,16	1,34	0,92	5,08	1,18	0,92
Responsibility	4,36	1,60	0,76	4,44	1,46	0,78
"To have a home"	5,03	1,31	0,84	4,41	1,58	0,89
Self-identity	4,83	1,28	0,84	4,51	1,60	0,88

6. Findings

From the mean values it is possible to identify the compliance trend of each participant in relation to each item and it is also possible to find out the average values for the different dimensions of psychological sense of belonging. Thus, the means of 5,019 for Self-efficacy, Self-identity and "Own a House" mean that operators agree with these feelings toward the production line. The sense of Territoriality (mean of 2.15) was lower and only agrees in part with the sense of Responsibility. The analysis of the averages presented in Table 2 provides the interpretation that operators, in the feelings of "To Own a House", Identity and Responsibility, agree only in part with these senses about each area. Yet, on the sense of Efficacy, in reference to the Area, the operators report that they agree with the expressed statements. In contrast, regarding the sense of Territoriality it is shown a mean value that shows disagreement with this feeling for both the production line and the areas. Concerning the areas by analysing the Responsibility, "To Own a House" and Identity dimensions, it is possible to see that, in average, the operators agree with the sentiments of this dimensions as well as the Self-efficacy dimension. (C.f. Table 1).

On average, the Self-efficacy dimension has the highest score. This dimension is the ability of an individual to believe in their personal capacities to perform a certain task. This way, it is possible to say that the company operators believe in their abilities and believe in their competence to achieve and perform tasks successfully.

There were defined four dimensions to the Area, related to the items presented for answer. The main goal was to define the dimensions portrayed by operators, Identity and "To Own a House" (1), Territoriality (2), Responsibility (3) and Efficacy (4). It is remarked that, for the dimensions, resulting from the operator's Area, self-efficacy is distinguished faced to the operator's Line, since this dimension forms a single dimension, what induces the idea that operators emphasize the relevance of self-efficacy for the explanation of dimensions in the factorial study.

Grouping of items depending on production areas and lines

In diagram 1 it is possible to check out the grouping of each dimension items according to the Production Areas and Lines. The responses are analysed in order to them. The dimension Territoriality comprises four items: "I feel

that I have to protect my ideas of being used by others" (T1), "I feel that people who I work with should not invade my working area" (T2), " I feel that I need to protect my area of being used by others "(T3) and" I feel I have to say to the people who work in my area to drop out of my own projects"(T4). The dimension Self-efficacy includes three items, namely "I am confident in my abilities to contribute to the success of my area" (E1), "I am confident that I can have a positive contribution in my area" (E2) and "I am confident towards the establishment of high performance goals in my area "(E3). The Responsibility dimension considered three items: "I would challenge anyone to see if anything is being done wrongly in my area" (A1), "I would not hesitate to communicate to superiors if I saw someone doing something wrong" (A2) and "I would challenge the company Administration to check if everything is correct in my area". For the dimension "To Own a House" and Self-identity there were six items: "I feel I belong to this area" (PL1), "In my area I feel like being at home" (PL2), "I am totally comfortable working in this area " (PL3)," I feel that the success of my area is part of my success " (I1)" I feel that this area helps to describe who I am" (I2) and" I feel I need to defend my area when it is criticized "(I3). (Cf. Diagram 1)

When the various syntheses, about the sense of belonging according to the production areas and lines, are examined through factor analysis it was quite clear the existence of a sense of belonging. It should be considered that the sense of belonging level is expressed through its dispersion in the various company's production lines and areas. On the other hand, the dispersion also expresses the concentration/dissemination of this sense in each of the lines and areas.

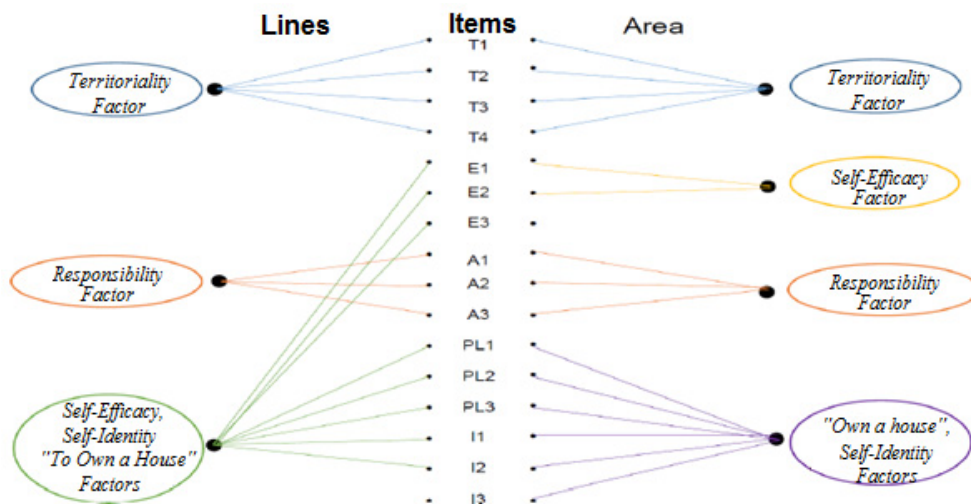


Diagram 1 - Grouping of the Psychological Ownership Questionnaire dimensions according to the production line and area.

The analysis of the sense of belonging contents for each of the production lines was made through factor analysis, allowing to understand which one of them showed better consistency. On Tables 2 and 3, the different company sections position is classified by a ranking. In view of the results it was found that, overall, the General Warehouse operators (both in Line as Area) reported a greater sense of belonging. The Dairy is the area where the sense of belonging is lower.

Regarding the dimensions Self-efficacy, Self-identity and "To Own a House", the sense of belonging is more noticeable in the following areas: General Warehouse, Process and Palletising. And it is lower in the Dairy.

With regard to the dimension Territoriality, the sense of belonging is higher in the General Store, Processing and Ercas sections. Finally, on the Responsibility dimension, the Palletising section, the Ercas and Warehouse occupy the first 3 places. (c.f. Table 2).

Tabela 2: Ranking of the Sense of Belonging levels, in several sections, according to Production Lines

Index / Position	Sense of Belonging dimensions according to Production Lines		
	Self-efficacy, Self-identity and "to Own a House"	Territoriality	Responsibility
1°	General Warehouse (0.06)	General Warehouse (0.28)	Palletising (0.08)
2°	Processing (0.13)	Processing (0.46)	Ercas (0.19)
3°	Palletising (0.31)	Ercas (0.51)	General Warehouse (0.28)
4°	Ercas (0.49)	Palletising (0.54)	Processing (0.30)
5°	Líquids (0.50)	Líquids (0.69)	Líquids (0.33)
6°	Dairy (1.37)	Dairy (0.78)	Dairy (0.63)

The levels of the sense of belonging found by factor analysis for each of the company's areas have revealed that the General Warehouse is the area where operators have shown greater sense of belonging and the Dairy is the area where the sense belonging level was lower. (c.f. Table 3). Regarding the *Self-efficacy* dimension, the sense of belonging was more noticeable in areas of the General Warehouse, Palletising, Liquid and Processing, being lower in Dairy. As for the sense of belonging in the dimension "To Own a House" and *Identity*, these are higher in the area of processes and lower in Dairy. The Processing area reveals a lower sense of belonging in the *Territoriality* dimension, and the General Warehouse is the area where it is revealed a greater sense of belonging towards this dimension. With regard to *Responsibility*, it is possible to see that the sense of belonging is greater in the Palletising area and lower in the Dairy (cf Table 3).

Table 3: Ranking of the Sense of Belonging levels, in several sections, according to Production Areas

Level/ Position	Sense of Belonging dimensions according to Areas			
	Self-efficacy	"To have a home"	Territoriality	Responsibility
1°	General Warehouse (0.00)	Processing (0.00)	General Warehouse (0.25)	Palletising (0.08)
2°	Palletising (0.00)	General Warehouse (0.25)	Palletising (0.62)	Ercas (0.17)
3°	Líquids (0.00)	Ercas (0.33)	Líquids (0.75)	Processing (0.21)
4°	Processing (0.00)	Palletising (0.58)	Dairy (0.83)	General Warehouse (0.28)
5°	Ercas (0.50)	Líquids (1.00)	Ercas (1.18)	Líquids (0.29)
6°	Dairy (2.00)	Dairy (1.50)	Processing (1.40)	Dairy (0.66)

7. Conclusion

Various TPM tools, with special focus on the autonomous maintenance ones, were implemented in industrial context. With the cooperation of the studied company's operators and administration, we have developed the operational management areas of responsibility, and those with greater autonomy in the daily management of operators and application standards self-maintaining.

The implementation of autonomous maintenance tools promoted the interaction between operators and equipment. Creating a plan, it was possible to operators and the company to develop monitoring and interaction with the studied section's equipment. It also provided a continuous abnormalities detection and anticipation which resulted, logically, in decreased faults, breakdowns and quality defects.

The strategic management of maintenance activity is to have the team acting to prevent possible failures. The new form of organization and arrangement of some areas provided work functional improvements. It was found that operators have a sense of belonging to the company's production lines and areas, mostly in the General Warehouse and in the Palletising section.

The development of the sense of belonging promoted a climate of continuous effort towards the targets of belonging. The interest of operators for their work and performance was stimulated, providing organizational advantages at all levels. In addition to the planning work operating performance level, there was improvement in the workers' attitudes. These results are consistent with the reported by Gupta, Tewari et al. (2007) when they say that the TPM establishes a close relationship between the maintenance and productivity, showing how good care and proper equipment maintenance results in higher productivity. These authors also point out that TPM is a philosophy of continuous improvement that creates a sense of ownership in each machine operators, along with their supervisors. Currently, in companies, the operators' working profile is associated with the set of tasks or actions for which each individual is responsible, and studies imply that the creation of these tasks is structured around the models developed by top management and applied to jobs hierarchically lower, putting the operators in a passive process where they only assume the functions presented to them (Wrzesniewski, LoBuglio et al., 2013). From there emerges the need to design, plan and implement strategies and tools able to promote emotional ties in the search for strategies and mechanisms that can make the companies more sustainable, because the existence of a culture that promotes a sense of psychological ownership ensures the commitment of workers and generates increased levels of productivity.

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