PROJECT OF „TPM" IMPLEMENTATION IN A BIG FOOD PRODUCTION COMPANY – CASE STUDY

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Abstract: This work is about the implementation of TPM program on the example of the large food production company. Given topic has been formulated in response to the problems identified by the company in the production areas. The objective of the study was to complete assumption of responsibility for the operation of machines by operators, including maintenance, data analysis, machine performance monitoring and improvement, the preparation and implementation of training service and reliable inspection of machines and their state registrations.

Keywords: Lean Management, elimination of waste, Total Productive Maintenance (TPM)

1. Introduction

Today's market and technologies are characterized by constant change, forcing the company to seeking constantly economical and commercially viable solutions that can help in improving their work. In view of that situation, increasingly common solutions turn out to be the initiative from the methodology of Lean Manufacturing. LM is based primarily on the elimination of waste, continuous improvement and full commitment of the employees.
An important element of the LM concept, on which we want to focus on, is elimination of waste, which is defined as the failure to comply with the requirements of flow and it must be eliminated by anyone who is involved in the movement [1]. Way to fight with wastes is to implement production management methods and tools which are visible on the figure 1.

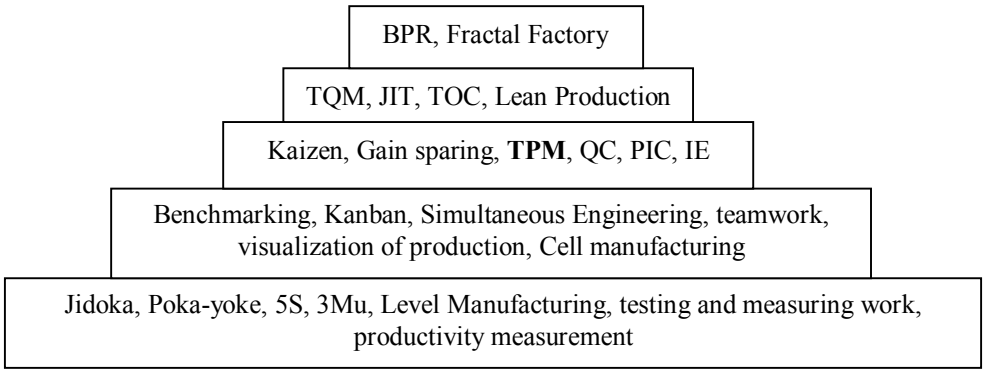

Figure 1. Management pyramid
Source: Own elaboration based on [2]

We are focusing on implementation of TPM program, because in company they already have 5S, which is the fundament of all more complex techniques, and in terms of time and cost this solution is the most optimal. Moreover, for food companies cleanness's on the

workstation is very important, because they have to fulfill certain standards, so company have to implement TPM tool for continuous improvement.

TPM concept is the aspects of enhancing the overall effectiveness (efficiency) of factory equipment, and providing an optimal group organizational approach in the accomplishment of system maintenance activities. Both the equipment and the organizational sides of the spectrum need to be addressed in fulfilling the objectives of TPM [3]. Many systems in use today are not performing as intended, nor are they cost effective in terms of their operation and support. Manufacturing systems, in particular, often operate at less than full capacity, productivity is low, and the costs of producing products are high. In dealing with the aspect of cost, experience has indicated that a large percentage of the total cost of doing business is due to maintenance – related activities in the factory; i.e. the costs associated with maintenance labour and materials and the cost due to production losses [4].

This article attempts to implement TPM method in manufacturing company. Implementation of such technique helps in better organization of time in company, greater order and cleanness. If we will introduce this we will have better efficiency of machinery and equipment. Research problem here is the issue of the problem of wastage and losses in the manufacturing company.

2. Characteristics of the research object

The project was carried out in a manufacturing company, occupying a leading position in the sale of sweets and located in the Mazovia Province. Currently employs 1050 workers, including 647 production facilities. Annual production amounts to approx. 20000 tons, mainly produced: Birds Milk, full chocolate, chocolates with fillings, chocolate candies. At 17000 m^2 of technical area are located 14 production lines, 3200 technical facilities, 1400 production machines and equipment. In recent times, there has been investment, thanks to which was created new laboratories, employee lounge, Bird Milks line L2, offices, as well as a unique manual workshop, which formed pralines. The work is done in three shifts, seven days a week.

In company we can distinguish several quality assurance systems like HACCP, ISO 9001, 14001, 18001, IFS – International Featured Standards and BRC – Global Standard for Food Safety and GMP – Good Manufacturing Practice. Internal proper operation of the Quality Management System is confirmed by audits carried out by the Department of Quality in both the manufacturing sectors, as well as enhancing the production departments, e.g.: in Human Resources, Maintenance. As we can see company strive to achieve global standards in quality and safety of food, but they forgot about the basic tools like TPM. Quality on the highest level and those systems which they have cannot be build without very stable ground, so it was decided to implement TPM program.

3. Analysis of losses in given manufacturing company

Company has a lot of problems on their production lines and because of that a lot of wastes in their processes were present: overproduction, all kind of waiting's, unnecessary transport and a lot of storage. Before project implementation:

- production staff themselves trained and determined skill level of machine operators,
- machine condition assessment performed by the service had little meaning,
- operates a centralized technical team system of supervision for production machines,
- participation of all the preventive work carried out by the maintenance was small,

– lack of time to take action to eliminate the root causes of defects and failures,
– did not use fully the indicators and analysis of the situation and condition of the equipment.

Moreover, there were a lot of financial losses according to production lines stoppages, cause of stoppages are shown on chart 1. In that company there is a lot of reported faults i.e. wrong setup of machine, machine broke up or a lot of production waste. According to those faults we have unplanned repair orders where line technicians must to act and production line do not work and company lose its capacity.

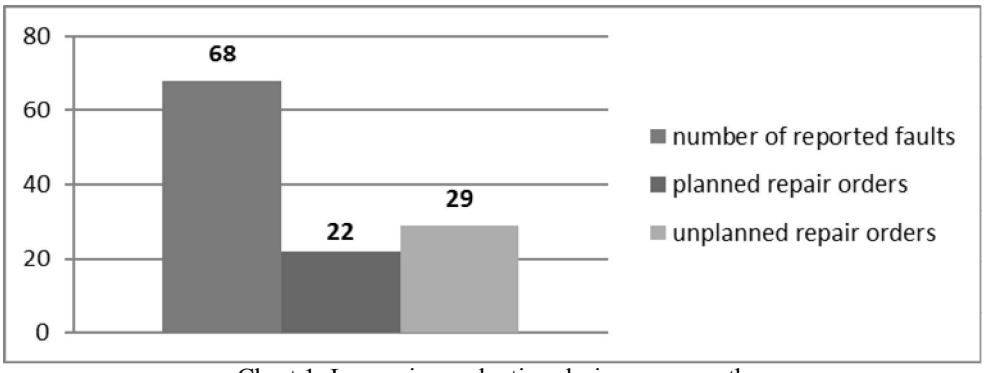

Chart 1. Losses in production during one month
Source: Own elaboration

While every single fault and unplanned repair orders means production inefficiency and reduced number of produced tones of products and additional costs for company.

Table 1. Causes and costs of loses

Cause	Cost [euro/intervention]	Cost [euro/month]
Unplanned repair orders	150	4350
Planned repair orders	50	1100
Number of reported faults	300	20400
Cost of production stoppage [euro/h]	**1500**	

Source: Own elaboration

When we have costs of all machines faults forming at the level of 25850 [euro/month], we can calculate the total cost of stoppages of machines per month and per year. According to the table 1 total cost of maintenance per month is equal to 25850 [euro/month] plus every 1500 [euro/h] when production stops.

4. Plan and program of TPM implementation in given company

Accepted area for the implementation of the TPM:
– AM – autonomous maintenance of machinery,
– PM – complex preventive actions maintenance services.

Goal of TPM implementation project is to engage machine operators in a process of thorough cleaning, changeovers, regulations, current inspection of the technical condition and maintenance. Also maintenance technicians undertake repairs of reported faults but mainly operate in the area of preventive maintenance of specialized equipment and priorities are: zero accidents, faults and defects of quality.

TPM program will be addressed to the following occupational groups:

- managers at all levels,
- production team leaders,
- maintenance technicians,
- TPM instructors,
- machine operators.

Below in the sections is presented the work program for the implementation of TPM in the company:

1) AM – autonomous maintenance of machinery:
   - conduct workshops of AM,
   - implement visualization,
   - implement individual responsibility for the machine,
   - trainings of operators of machines by instructors of TPM,
   - increasing standards of workstations,
   - implement program through which every employee can submit and implement an idea for improvement.
2) Specialized Equipment Maintenance;
3) Predictive Maintenance - service tailored to the needs.

5. Implementation of project

Implementation was started from AM program, which is a method to solve the fundamental problems in the work of machinery. Thanks to the 4S implementation in the company equipment is clean and efficient, ideas and improvements of machinery are implemented, complement the functional descriptions of the setting, autonomous machines inspections are realized, constantly improve the competence of operators, there is responsibility of operators for the machine and there is constantly monitoring of results.

Firstly in TPM implementation there is need to conduct workshops of AM which have in their program:

- familiarize operators with TPM program,
- very thorough cleaning of machines,
- accurate assessment of the equipment technical conditions,
- removal of simple faults,
- creating ideas to improve,
- assessment of service skills,
- first trainings.

Then it is necessary to implement visualization on the every production line where we can find Autonomous Maintenance boards (figure 2) and visualization of the descriptions on the work positions (figure 3).

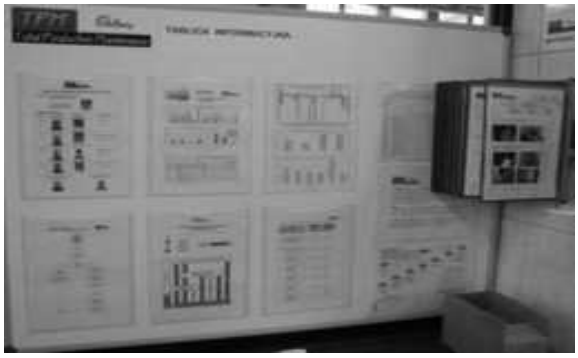

Figure 2. Autonomous Maintenance boards
Source: Own elaboration

On the visualization boards worker can find organizational structure of Maintenance Department and particular person which is responsible for specific production line. There also maintenance employee put efficiency of line, capacity per shift, One Piece Lessons, instructions of machines and maintenance goals.

Visualizations of workstations also were implemented, where it was needed. That process focused on control points for example level of oil, feedstock or pressure point to allow machine operator for control of situation. Moreover, places where dirt is often collected and places of fabrication were marked, thanks to that operator know where and how to response. Those visualization tools helps to eliminate waste of time spending on looking for norms for particular machine, necessity to call maintenance technicians for simple cleaning or repair and increase safety of production area.

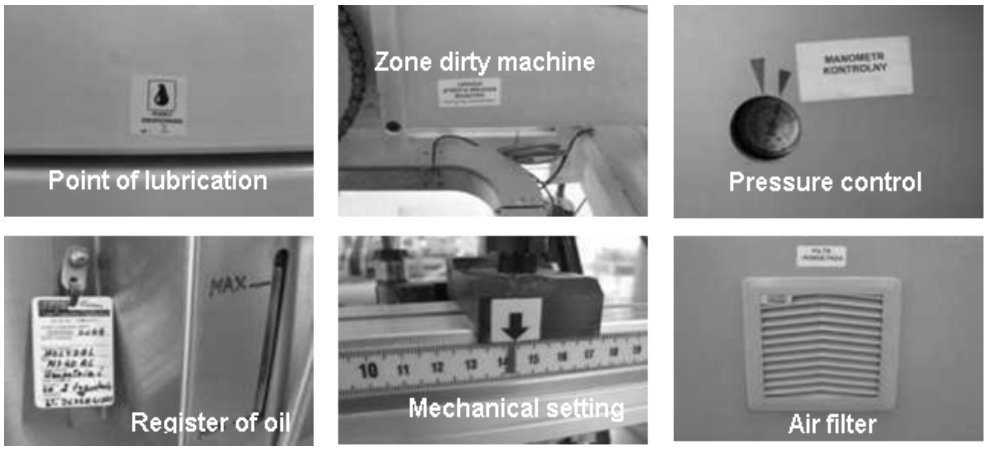

Figure 3. Description of workstations
Source: Own elaboration

Implementation project assume also simple improvement in the form of labels for every production line which tell if line is working (efficient), have fault and it works or is in the state of quick repair or its broken (failure) and it temporary do not work. According to that operators constantly visualize the condition of the machine (figure 4).

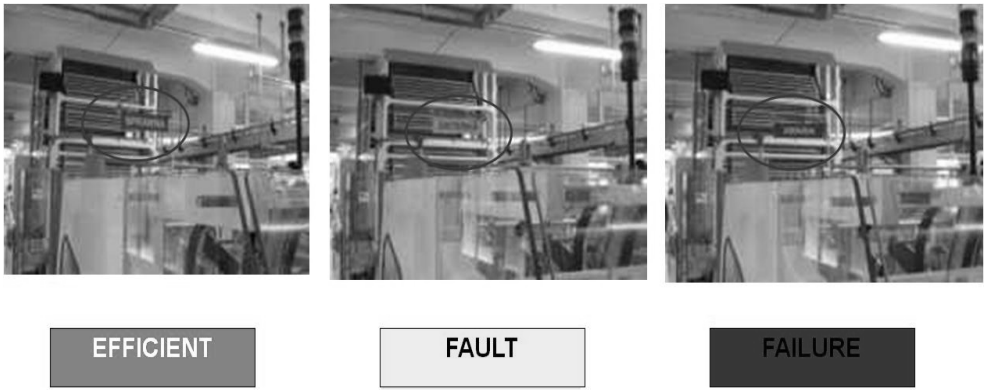

Figure 4. Visualization of machines in company
Source: Own elaboration

Further, in this point it is also important to implement individual responsibility for the machine. That means that machine or production line will have not only maintenance technician to take care after them but also every operator have in their responsibilities maintenance of specific machine.

Every machine have its own person which is responsible for it and depends from the skill level in realizing maintenance program. Company distinguish four levels of skill, every level have its own color and during every shift on the or nearby machine there is cuvette with skill card and picture of operator which works on this shift. According to that when something is wrong with machine we know to whom we can go.

Those skill cards were created on the base of skill matrix (where we can distinguish those four colors) which was designed for every production line. Trainings are an important part of TPM, so in next step operators are trained by instructors of TPM. In project we also standardize the trainings of operators. Operators' skills are developed through the program: "The Academy of Operator". There were also developed training tools like: training program, skill card and skills matrix (figure 5).

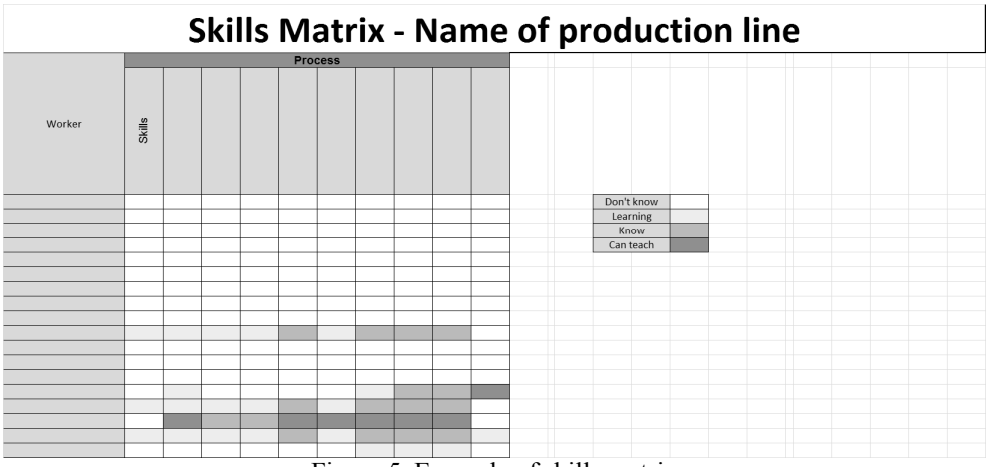

Figure 5. Example of skills matrix
Source: Own elaboration

Trainings are tool which increase workers competences and operator knows:

- the basic operation of the machine,
- effective cleaning of machine,
- preventive supervision of components,
- advanced operation of the machine,
- self-regulation of machinery,
- self-changeover,
- lubrication of machine components,
- making simple repairs,
- medium and large repair.

Next step is increasing standards of workstations by marking additional tools and equipment, measurement of process conditions and warnings. TPM implement additional simple tools for uncomplicated repairs and every tools is dedicated to particular machine and also were developed warning standards and placed near machine.

"I have an idea for improvement" it is a program through which every employee can submit and implement an idea for improvement. It may relate to improving the safety, efficiency, quality, working conditions, equipment or methods to reduce costs (figure 6).

Figure 6. Realized ideas of employees
Source: Own elaboration

Implemented ideas are nominated for individual awards monthly, quarterly and annual.

Next large step is to implement Specialized Equipment Maintenance. In this part will be distinguished actions which have been taken to introduce preventive maintenance in TPM project. Firstly were defined tasks for technicians of AM and PM.

Tasks for technicians (AM):

- technicians instructor for operators,
- does not perform independently regulate just supervise,
- guards the course of carrying out the tasks of production,
- responds to anomalies/fixes.

Tasks for technicians (PM):

- execute planned repairs,
- performs preventive maintenance,
- measures and forecasts the component wear,
- implement improvements.

It was also necessary to redevelop the organizational structure of Maintenance Department, because new positions and new responsibilities were appeared (figure 7 and 8).

Where in old organizational structure company have several maintenance workers which were delegated to every production line and have unclassified responsibilities, now every production line have it own Manager of Technical Support Line and he coordinates work of Technicians Team. Manager of team and also team response before Manager of Production Area and Manager of Maintenance. Those Line Technicians Team (Technical teams UR) are divided into workshop teams and shift teams. Every teams have its manager, mechanic, automatic, energeticist and electrician. Locksmith or turner is present on every shift but he is not part of maintenance team, because he must to prepare or redesign tools and equipment.

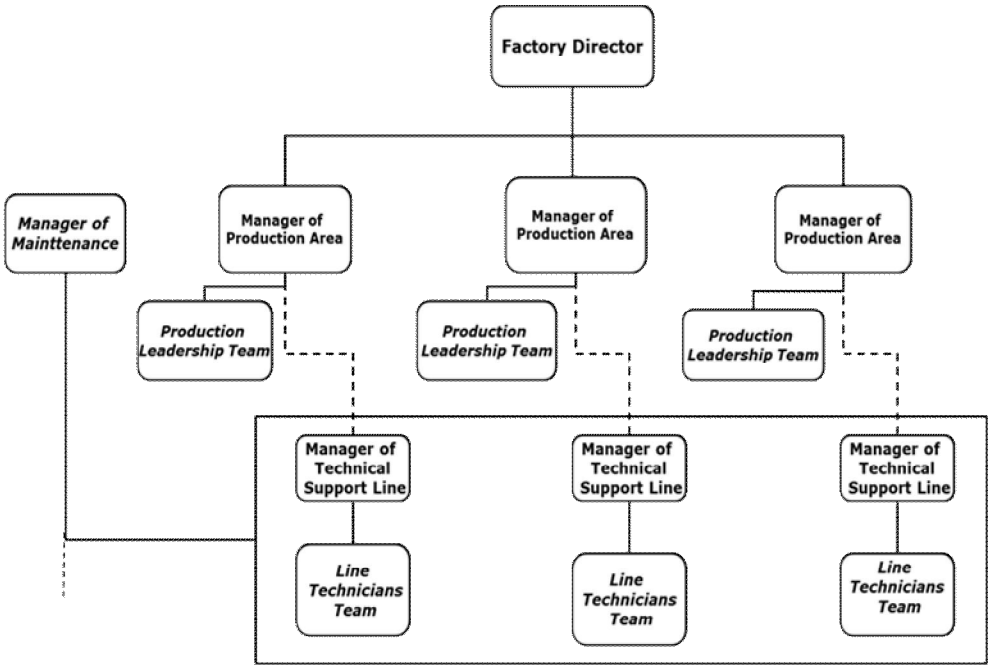

Figure 7. Organizational structure of Maintenance Department
Source: Own elaboration

This type of organizational structure designing is very useful, because on every shift, in every workshop team there is specialist it is own area.

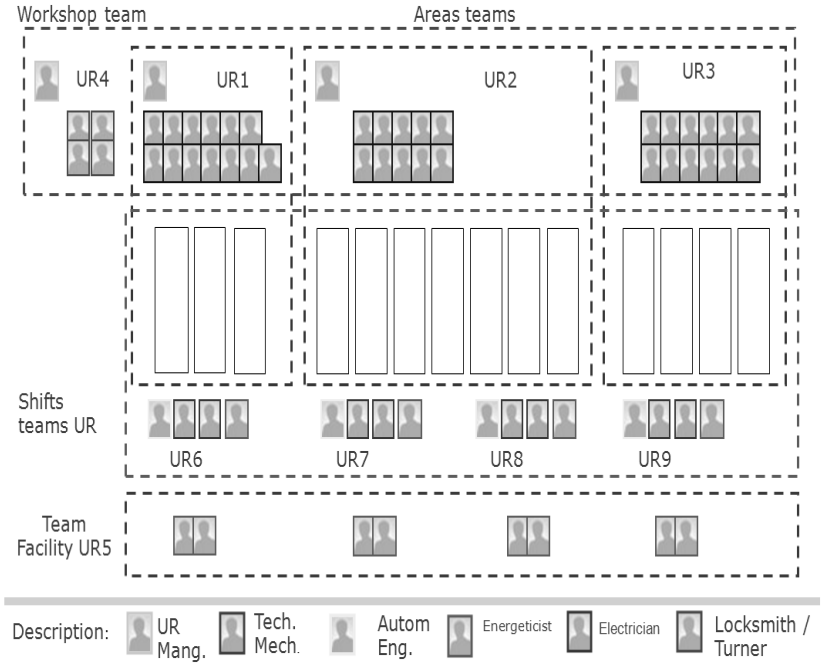

Figure 8. Technical teams UR
Source: Own elaboration

Last step is to implement Predictive Maintenance, according to which technicians perform periodic checks according to the developed instructions of PM. Due to the Preventive Maintenance in the project company wants to optimize expenses on maintenance in the factory by:

- constantly monitor indicators (KPI),
- conducting ongoing analysis of the costs,
- monitoring the extent of implementation of the budget,
- achieve a failure rate of <1,5%,
- apply Lean Maintenance principles,
- effectively manage teams,
- conduct prudent shopping of parts,
- judiciously employ of contractors.

On the end of this project company want to have effective teams management, that's why it was created a schedule for work of technical teams. In project was also implement visualization of scheduling, also to effective management of teams.

Figures of level of planning, loading level and types of activities unscheduled in time are on the every board in every production line, so that employees can see the effects of TPM implementation. We can observed that according to the work time level of planning, loading level and unscheduled activities decreased. Thanks to that employee have more time to his work which add a value to the product.

6. Conclusion

Assuming that the product price is 900 [euro/ton] and the line variable cost is 10 [euro/ton] we can calculate how much we can save. In the table 2 has been awarded that after TPM implementation, annual production increase by 206 tons per year so it is convenient, because the output is increased with a benefit of 183340 [euro/year] with cost only two additional person 80000 [euro/year].

Table 2. Comparison of expenditures and savings

Product price	€ 900,00	euro/ton
Unit variable cost (related to line)	€ 10,00	euro/ton
Product marginal contribution (related ONLY to the line)	€ 890,00	euro/ton
Production in standard conditions	20 218	ton/year
Production in current conditions (+2 operators and MTTR=MTTR/2)	20 424	ton/year
Delta production	206	ton/year
Value of extra production (or cost of losses from other point of view)	183,34	keuro/year
Cost of 2 persons	80	keuro/year

Source: Own elaboration

In the effectiveness evaluation for company it is important number of repair orders, the number of reported faults, percent of downtime and percent of downtime of first machine on which TPM was implemented. Those all indicators are presented below.

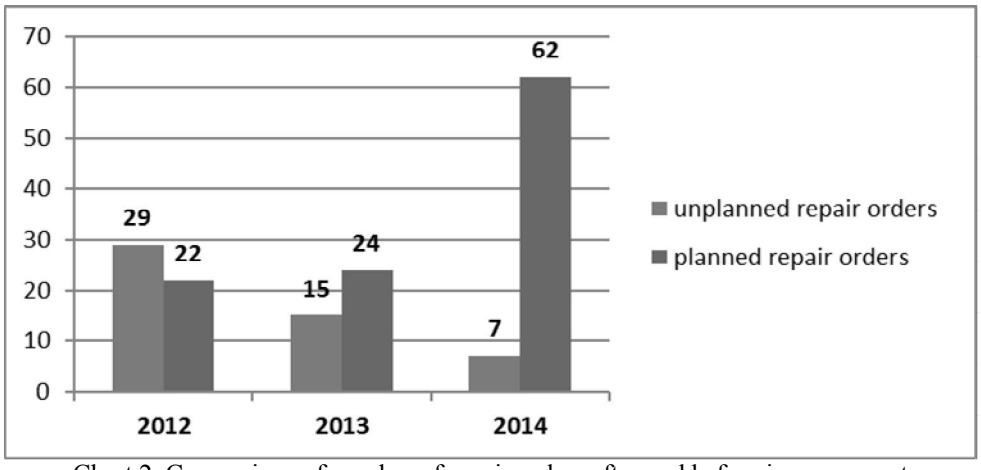

Chart 2. Comparison of number of repair orders after and before improvement
Source: Own elaboration

For the company those indicators are KPI (Key Performance Indicators) and it tells as how production works. Number of unplanned repair orders during two years decrease significantly from 29 to 7, thus number of stoppages and its costs decrease. Moreover, it let

company to save 95700 [euro/month]. Planned repair orders are the result of Preventive Maintenance and now they are conducted out of production shift, thanks to this company do not held any costs connected to the production losses.

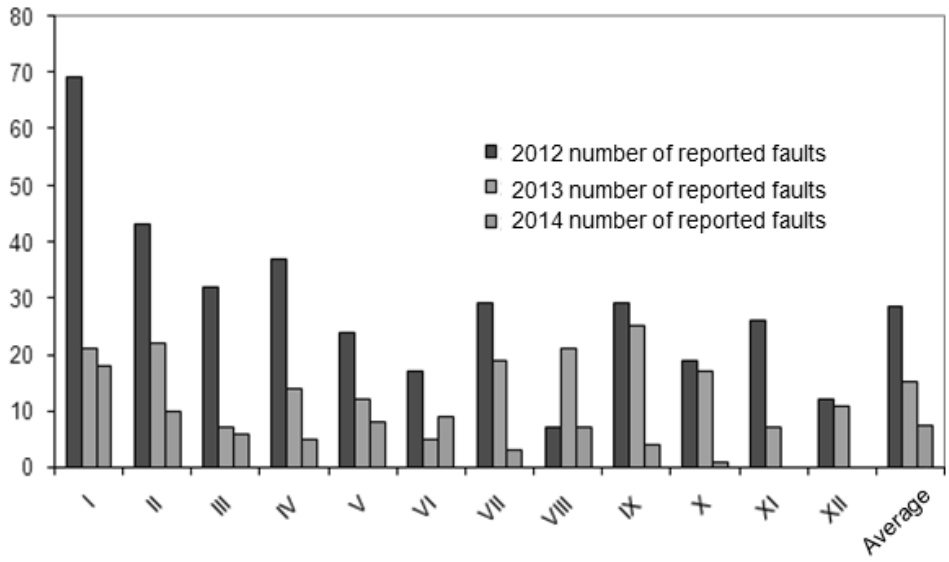

Chart 3. Number of reported faults over three years
Source: Own elaboration

From chart 3 we can conclude that average number of reported faults decrease from about 30 to less than 10, which gave 408000 [euro/month] of savings for company.

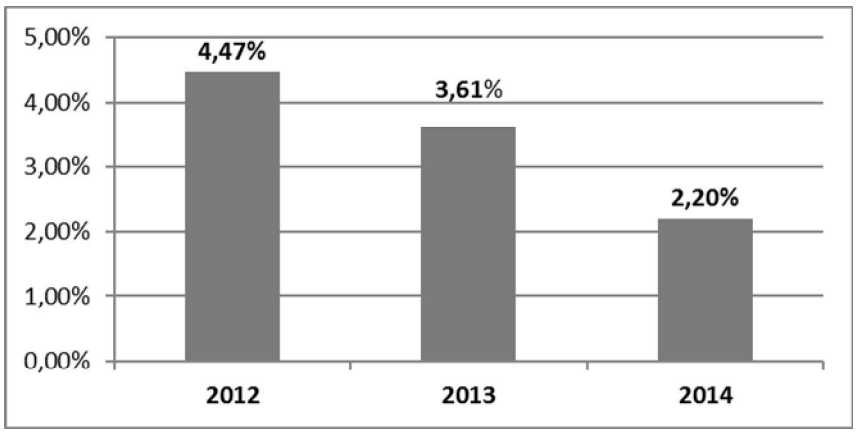

Chart 4. Percent of downtimes on the first machine with TPM program
Source: Own elaboration

Downtimes are also KPI for company and it was calculated for the first machine covered by the program of TPM what percentage of the total time are downtimes. We can see that for the working time of machine we gain 2,2% more time to produce.

From Charts 2, 3 and 4 we can see that in every case after implementation of TPM adverse effect decrease. On the basis of those charts we can conclude that for production all of this indicators decrease significantly which give a lot of savings and more time for the value adding activities. Thanks to this program company can eliminate waste in his processes.

We can distinguish also the incommensurable effects of TPM implementation:

- greater attention to the technical condition of machines guarantees the safety and quality of our products,
- detailed inspections and early detection of defects increase the chances of avoiding emergency stops,
- efficient response to sudden disruption increases the efficiency of production lines,
- operators are keen to develop their own skills and are ready to take over part of the maintenance tasks,
- greater responsibility for machinery and tooling of workstations.

The result of the project was the reorganization of the operators and their environment, so that the proposal has been prepared: complete service technicians production departments TPM, reduce maintenance costs of machinery and new investments for the company.

References

1. Ciesielski M.: Instrumenty zarządzania łańcuchem dostaw. Polskie Wydawnictwo Ekonomiczne, Warszawa, 2009.
2. Santarek K.: Zarządzanie produkcją. PW WIP IOSP, studia doktoranckie, Warszawa, 2012.
3. Blanchard B.S.: An enhanced approach for implementing total productive maintenance in the manufacturing environment. Journal of Quality in Maintenance Engineering. MCB UP Ltd, Sweden, no 3, 1995.
4. McKone K.: The impact of Total Productive Maintenance practices on manufacturing performance. Journal of Operations Management. ELSEVIER, USA, no 2, 2000.

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