Lean Management "Quick-Wins": Results of Implementation. A Case Study

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ABSTRACT

Purpose: This study comprised two main goals. The first goal demonstrates how LT (Lean Tools) allows the highest impact during the implementation phase.The second goal consisted of introducing procedure changes based on the Management of Human Resources through Lean Leadership tool. The target for these two objectives is to achieve an increase of 5% in machine occupancy rate and a reduction of 10% regarding the costs of defective products per hour.

Methodology/Approach: The research methodology is a Action-Research/Research-Action developed by Professor Kurt Lewin of MIT that goes through cycles of five stages: Diagnosis; Planning; Implementation; Evaluation, Conclusions.

Findings: Regarding the two objectives above mentioned, it was observed an increase of 8.5% in machine occupancy rate and a reduction of 27.9% regarding the costs per hour of defective products. It was created an additional motivation in the employees and very satisfying results in every production.

Research Limitation/implication: The study is limited to a Portuguese Small and Medium-sized Enterprise (SME) in the metalworking sector.

Originality/Value of paper: Lean tools can be rapidly and easily implemented and quickly understood by the workers. With that implementation, the occupation of the machines has increased and the defects and their costs have decreased, so the added value grows.

Category: Case study

Keywords: management by objectives; KPI; Daily Kaizen; visual management; Yokoten

1 INTRODUCTION

The present work was developed in a metalworking design and development company, with the manufacturing unit headquartered in the north of Portugal, which exports to foreign market, and which needs to increase its productivity rate in the machining area. This productivity increase is essential in order to face competition from the European market, with innovative products and production from Asian countries that do not compete in terms of quality but have a price-quality ratio that makes them a threat. The increase in the productivity rate and, consequently, the increase in useful, productive hours must be achieved, keeping the human resources in the company with more efficient management of the existing equipment and acquisition of new ones by using Lean Tools (LT).

This study was developed in a company where metal cutting machines for trimming are the most usual equipment. Thus, the best working philosophy is to group by Manufacturing Cells. Depending on the product to be transformed, the production cells respond effectively and efficiently to demand fluctuations, as well as to product varieties. Improving space optimization, provided by this type of layout, increases performance, and substantially reduces waste. The concept of value is the basis of this philosophy, aimed at increasing competitiveness and keep a continuous improvement philosophy (Sá and Oliveira, 2013; Santos and Barbosa, 2006; Santos, Murmura and Bravi, 2019). The company has structured its equipment in 4 cells (16 machines in total), grouped by typology of machine and volume of parts to be machined. The raw material to be transformed also influences the equipment selection, depending if they are plastics, metallic rods, cast or forged components. The company has in its stock milling machines (usually called "Centers") and Computer Numerical Control (CNC) lathes, comprising 3 Centers/Milling Machines and 13 CNC Lathes at the beginning of the study, which has increased to 15 at the end of the study. They are also supported with two milling cutters and a conventional lathe, which do not fit into the calculations presented in this work. The machines have a performing work capacity up to 1,000 mm length.

2 LITERATURE REVIEW

Due to a constant change in customer needs, entrepreneurs need to make effective decisions to succeed (Aas and Alaassar, 2017), and the future success of the organization depends on the extent to which we succeed in adapting to the rapidly advancing changes in the organization, without neglecting the values for which the business is oriented (Dana, 2015; Lisiecka and Burka, 2016; Santos et al., 2018). The search for competitive advantages over competitors is one of the strategies needed for companies that want to survive (Pinto, Pimentel and Cunha, 2016; Bravi, Murmura and Santos, 2017). It is vital to improving productivity with the latest technology for any production or service industry. Quality and productivity help a company stay in the global marketplace (Bravi, Murmura and Santos, 2019; Araújo et al., 2019; Doiro et al., 2017). Technology has become

extremely useful for the search for new customers (Krishnan et al., 2018; Bravi, Murmura and Santos, 2018).

In an increasingly competitive environment, it is necessary to effectively manage the companies' processes (Veres et al., 2018). Lean contributes positively to business performance applied in a manufacturing context and is also suggested to do the same in a service context (Andersson, Manfredsson and Lantz, 2015). Thus, a lean production initiative is focused on reducing costs and increasing turnover, systematically and continuously eliminating all non-value-added activities. In a competitive market, Lean is "the solution" for manufacturing industries' survival and success. Lean production helps organizations achieve targeted productivity by introducing easy-to-apply and maintenance-friendly techniques and tools. Its focus on waste reduction and elimination allows it to be rooted in the organization's culture and turns all processes into profit (Oliveira, Sá and Fernandes, 2017; Zgodavova, Hudec and Palfy, 2017).

The Lean Production (LP) paradigm focuses on the elimination of activities with no added value, seeking the use of the smallest space required for production, by the lower number of workers; by the smaller work-in-progress (WIP), for shorter stoppages (Mahendran and Kumar, 2018). Thus, LP (Lean Production) has gained worldwide popularity as a means to reduce waste, improve quality and increase the competitiveness of companies (Zalatar and Siriban-Manalang, 2018), contributing to the survival and success of companies (Oliveira, Sá and Fernandes, 2017; Pinto, Pimentel and Cunha, 2016). It can say that the implementation of LP (Lean Production), even in a fragmented way, helps companies to achieve improvements in operational performance (Filho, Ganga and Gunasekaran, 2016).

Lean Leadership is a methodical system for the sustainable implementation and continuous improvement of Lean Production (Bäckström and Ingelsson, 2015). It describes the cooperation of officials and leaders in their mutual endeavor towards perfection (Dombrowski and Mielke, 2014).

SMART – is an acronym for a goal setting practice. The objectives should be: - "S" specific, "M" measurable, "A" attainable/achievable, "R" relevant and "T" timely. Its origin is attributed to the Management by Objectives developed by Peter Drucker. The focus of it is to ensure that an organization's teams are working towards the same goals, while SMART sets out the action plan. Although SMART is often a contributor to business management, SMART has also been used in the formulation of personal development plans (Campbell, 2018). The measurement of key performance indicators is a widely used instrument to detect changes in the performance of the production system to coordinate appropriate countermeasures. The main challenge in the KPI systems coordinator is to determine relevant KPIs (Stricker, Minguillon and Lanza, 2017; Zhu et al., 2018). The absence of adequate productivity measurement indicators leads to disoriented performance (Azizi, 2015).

Daily Kaizen meetings are the main subsystem of corporate accountability that enables the culture of continuous improvement, working efficiently in the form of visual management, analysing and acting based on data and root cause analysis, seeking to continually improve its operations in a structured and visible manner (Zarbo et al., 2015; Verbano, Crema and Nicosia, 2017). Integrated in the internal communication project, it is intended that, daily, the entire company has data for decision making. This communication is performed transversally and vertically. Base LEAN Leadership project, in which communication is one of the pillars for the development of employees and for decisions to be made in a timely manner (Carvalho, Santos and Gonçalves, 2018; Santos, Bravi and Murmura, 2018).

Visual management is by itself the management tool that quickly informs its stakeholders about the state of a process and which actions can be taken in a timely manner. It allows team leaders to better engage in problem solving and practice of continuous improvement with their teams (Bateman, Philp and Warrender, 2016).

PDCA is a system for continuously improving an organization. The “Plan” phase initiates the PDCA process by identifying the problem clearly and objectively. The “Do” phase takes the hypothesis and tests it by the scientific method. The “Check” phase is initiated to study the effects of the “do” phase. Facts are revealed, analysed, and discussed to determine what worked and what did not. The “Act” phase is sometimes referred to as “analysing” because it is designed to identify what worked and what did not, and why (Schwagerman III and Ulme, 2013).

The Gemba Walk concept is essentially the time when top management goes to the actual place where the work is performed (Gesinger, 2016; Southworth, 2012; Ahmed, 2014) and to the place where value is created (Nestle, 2013). This is also, an opportunity for leaders to communicate and building trust with the team, enhancing corporate culture with a focus on people and processes (Minter, 2015), having an immediate and significant influence on organizational activity (Dana, 2015; Santos, Rebelo and Santos, 2017).

The 5S system is a rule-rule designed to create a clean and secure working environment (hence, there is a commitment to safety (Czifra, 2017), productive and to provide efficient and effective fulfilment of business tasks. The tool 5S is divided into five steps, which can be enumerated as follows: SEIRI (Sort)/SEITON (Set in Order)/SEISO (Shine)/SEIKETSU (Standardize)/SHITSUKE (Sustain) (Sharma and Lata, 2018). The need to have the 5S method implemented is one of the first steps of the Lean Manufacturing strategy (it has an influence on the behaviour of the LS method). Dana (2015) determines, as a result, the organizational productivity increase (Veres et al., 2018), as well as the increase in operational and profitability indicators in the short and long term, medium term, manufacturing costs and positively affects profitability (Todorovic and Cupic, 2017).

The 5 "Whys" is a technique that uses a systematic approach to problem solving in order to find the root cause of a defect or problem (Mehltretter, 2018). The goal is to identify the negative event factors and determine what needs to change and to avoid similar future occurrences (Marques et al., 2018; Costa, et al., 2019; Santos et al., 2019; Rebelo et al., 2016).

3 METHODOLOGY

The research methodology is Action-Research/Research-Action, developed by Professor Kurt Lewin of MIT who goes through 5-stage cycles:

(1) *Diagnosis*

(2) *Planning*

(3) *Implementation*

(4) *Evaluation*

(5) *Conclusions* (Neumann, 2013).

The first stage, (1) *Diagnosis,* which identifies the problems that are affecting the organizations 'performance, like the handicap that Lean agents have using and implementation of LT for solving problems in companies, was performed in November and December of 2018. This diagnosis allowed a more detailed collection of the company's KPIs (Key Performance Indicators), as well as the study of the main productive processes and subprocesses, the organization's management of resources flows of people and the components and parts produced. During this period, the State-of-the-Art study of the main Lean Tools (LT) and Leadership Lean (LL) was also started, collecting information on the best practices worldwide in each of the areas.

The second stage, (2) *Planning*, consists of collecting information about LT (Lean Tools) and LL, in order to organize and analyse which are the most appropriate for each phase of the project. At this stage, planning will be developed with proven methodologies for rapid successes and others that allow the "sustainability" of productive efficiency. The processes and methods of human resources management to be used, as well as the analysis of the methodologies that allow structural changes in the company, will also be carried out.

The intermediate stage, (3) *Implementation*, will consist of putting into practice the steps defined in the planning, collecting the results obtained during the process. The collected data will allow to verify the degree of implementation of the established measures.

In the fourth stage, (4) *Evaluation* – Analysis of the Data and validation of the implemented actions, all the registrations, and impressions of the stakeholders will be collected, and this will be the conclusion.

As regards the last stage, (5) *Conclusion*, considering all data available, it will be concluded if the premises are accurate, if the results are in line with expectations or if the trend is negative. This phase will allow the validation or not of the thesis, establishing the actions to be proposed later for the improvement of the company (Tab. 1 as an example).

Table 1 – Plan of Implementation of the "Action-Research"

	Nov, 2018	**Dec, 2018**	**Jan, 2019**	**Feb, 2019**	**Mar, 2019**	**Apr, 2019**	**May, 2019**	**Jun, 2019**
Diagnosis	X	X						
Planning		X						
Implementation			X	X	X			
Analyze					X	X		
Conclusion						X	X	
Presentation Conclusions								X

4 RESULTS

The following are the gains from applying lean tools.

4.1 Registration and Data Management

4.1.1 Occupancy Rate 2018 vs. Number of Equipment

Regarding the analysis needed to be carried out, a weekly baseline reference has been chosen. In this case, the best five weeks of 2018 were considered, namely the weeks 46 to 50. The occupancy rate is calculated based on the following rule: the percentage of effective working time recorded in each machine had been working for 8 hours (Tab. 2) and, even exists overtime work, it must be added to the availability of the equipment.

Table 2 – Occupancy Rate for Four Cells in Weeks 46 to 50 of 2018

	Week 46, 2018	Week 47, 2018	Week 48, 2018	Week 49, 2018	Week 50, 2018	Average	No. of equipment
	(%)						
Cell 1	57.1	598.0	54.3	47.4	63.8	56.5	5
Cell 2	58.4	64.7	52.9	55.4	49.1	56.1	4
Cell 3	60.6	56.3	53.0	41.7	61.1	54.6	4
Cell 4	41.7	45.2	44.2	45.8	40.6	43.5	3
Week (%)	54.3	56.5	51.1	47.6	53.7	52.7	Total 16

4.1.2 Hours Worked vs. Number of Employees

Using the same weekly basis for the occupancy rate, the number of worked hours by each work cell was recorded (Tab. 3). Depending on the number of employees available, as well as the components typology, the following worked hours were obtained.

Table 3 – Number of Worked Hours by the Four Cells in Weeks 46 to 50 of 2018

	Week 46, 2018	Week 47, 2018	Week 48, 2018	Week 49, 2018	Week 50, 2018	Average	No. of collaborators
Cell 1	125:44	136:11	121:59	84:05	148:17	123:15	5
Cell 2	129:47	135:39	115:47	125:26	91:57	119:43	5
Cell 3	84:20	81:00	78:03	56:02	83:03	76:29	4
Cell 4	51:45	55:46	52:57	59:15	48:50	53:42	3
No. Hours	391:36	408:36	368:46	324:48	372:07	373:10	Total 17

4.1.3 Production Rate of Conforming Parts

The KPIs (Key Performance Indicators) adopted by the company are measured regularly. The production rate is measured as a function of parts and not by the number of defective parts. In order to have more consolidated data, we present the data from September 2018 to December 2018 (Tab. 4). The objective was to have values greater than 98%, in which 99.6% were found.

Table 4 – Production Rate in the Last Quarter of 2018

Production	September	October	November	December	Average
Goal (%)	98.0	98.0	98.0	98.0	98.0
Results (%)	99.7	99.6	99.4	99.8	99.6

The costs of non-quality are easily understood and will be the basis of work to validate the case study. The non-quality costs due to the wrong machine operation by the workers are the sum of the cost of the raw material, plus the time/cost associated with the state of the part added of a fixed cost relatively to administrative costs. The results are shown in Tab. 5.

Table 5 – NC Quantities and Costs Regarding the Last Quarter of 2018

Production	September	October	November	December	Average	Total
Quantity NC	22	83	27	11	36	144
NC Costs (€)	870	553	620	393	609	2,436

4.1.4 Costs Non-Compliance vs. Number of Hours Worked

It was established the strategic objective of increasing the number of worked hours. The goal is to create a ratio between the number of worked hours and the nonconformities associated costs. The values regarding the year of 2018 shown in Tab. 6.

Table 6 – Costs of NQ/Production Hours

Cost of NQ/week (€)	Production Hours (h)	Ratio Costs of NQ/Production Hours
152.25	373	0.408

4.2 Application of Lean Tools

Ten tools have been selected in this work (Lean and Quality), expecting they generate great impact within a 3-month period, in association with the employees. The chosen tools allowed for changes in processes, manufacturing methods and cooperative management. After analysing scientific articles and determining the company's stage of maturity, the following tools were selected for implementation: (1) Management by Objectives/SMART Objectives – Each worker's objectives were controlled weekly; (2) KPI – A more generalized concept was transmitted to the entire company and its staff; (3) Daily Kaizen – besides being implemented in the main production area, it was also replicate to small areas (cells of production); (4) Visual Management – reformulated to include cells; (5) PDCA – tool used in daily Kaizen to progress in problem solving; (6) Gemba Walk – the process was performed to include the entire hierarchy, including the CEO; (7) 5S – introduction of the first 3 S to enable the spaces organization; (8) The "5 Whys" – to address the production of NCs (Non-Conformities) which require more complex solutions; (9) Yokoten: used to disseminate actions taken in the "5 Whys" throughout the manufacturing area; (10) Brainstorming – working with cell operators to find proposals for continuous improvement.

4.2.1 Management by Objectives/SMART Objectives

The objectives are usually defined for periods of 1 year, in the several articles studied. However, in this work it was decided to establish quarterly targets for the machining area, aiming at the achieved results will be immediately rewarded, being one of the main advantages. SMART goals are ambitious and achievable. In this sense, they have been proposed to be accepted by collaborators; the following objectives were set up for the first quarter (Tab. 7).

Table 7 – Management by Objectives 1st Quarter

Goal description	**Cell 1**	**Cell 2**	**Cell 3**	**Cell 4**	**Weighting/ Retribution (%)**
Occupancy Rate Cell	⩾61.5%	⩾61.1%	⩾59.6%	⩾48.5%	25
NC: Cost Not Quality	⩽0.3% of Budget				15
No expected components / No Components produced x 100%	⩾10% value in 2018				10
Customer Complaints- Non-Quality Costs	≤0.5% Budget				10
Billing Amount	Budget				20
Performance evaluation (Semester)	Grid 17 Questions + weighting				20
Total					100

An easy-to-read form has been developed, which establishes an "agreement" between the manager and the employee for the time period, in this case, the established quarter. The file is pre-established with formulas that according to the remuneration that the employee enjoys, and depending on the objectives achieved, gives the value of the bonus. Some general rules have been established: 1st the management agreement by objectives is valid only in the agreed period; 2nd the indicators should be monitored monthly, recording data as well as analysis of causes and actions, if the targets are not reached; 3rd there were regular audits to validate the process; 4th the final result will be rated according to the time in the service of the company; 5th in case of any irregularity in the data provided, the agreement will be considered voided and will follow the legal procedures; 6th the evaluation of the individual performance must be carried out in the first half of each semester; 7th the remuneration resulting from the Management by objectives will be distributed within two months after the closing date of the evaluation.

4.2.2 KPI (Key Performance Indicators)

All the ten processes of the Quality Management System in the company have their corresponding indicators, increasing to 32 KPIs (Key Performance

Indicators) on the company in 2019, because everything that cannot be measured cannot be improved. With Lean Leadership philosophy, the company started to disclose all KPIs (Key Performance Indicators) in the company's dashboard with access and explanation to all employees.

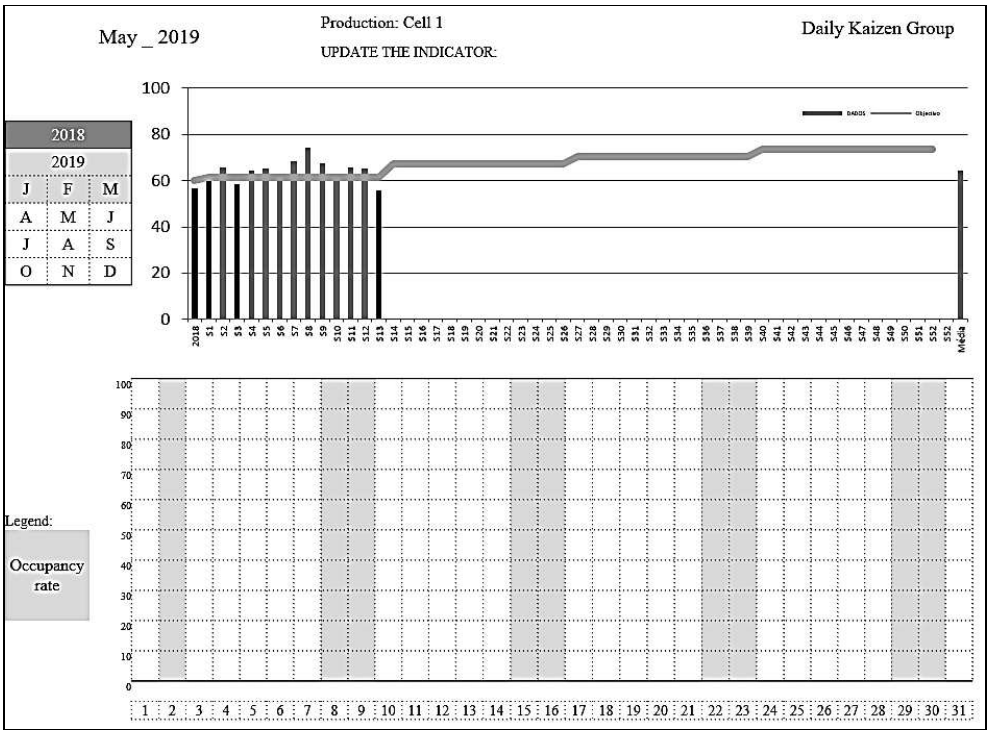

Figure 1 – Daily Occupancy Rate Control Example for Cell 1

4.2.3 Daily Kaizen

In the machining area, a "Daily Kaizen" meeting has been established, counting with the participation of the following collaborators: Machining coordinator, Planning manager, Cells manager, Times and Methods manager, and maintenance manager. This takes place every day from 9:50 a.m. to 10:00 p.m., receiving daily information from the 4 Kaizen factory cells. This meeting is performed at the beginning of the shift and will feed the relevant information for the next "operations" meeting. The example above, Fig. 1, shows the daily occupancy rate control of the cell 1.

4.2.4 Visual Management

The visual management allowed a quick indication of the productive state almost in real-time, and the data became available on the next business day. All employees from the top management to operators have important information in a simple and effective way. Graphs and data are easily perceived at 3 meters away, thus allowing easy assimilation of these.

4.2.5 PDCA (Plan-Do-Check-Act)

The PDCA tool was embedded in the Daily Kaizen panel which allowed the company to have the perception if results are within the objective. Possible proposals for improvements or needs of the sector are recorded as a plan of actions, which evolution of the work performed is daily verified by the person responsible for overcoming the problems, who, through the target objective, decisions and actions are taken when the expected results are not ok or when actions are over the established timings.

4.2.6 Gemba Walk

Gemba Walk, even unofficially implemented it was common practice to do. The Gemba Walk happens in a structured way. First, the coordinator passes with the integration of a level of kaizen daily, with the responsibility of production/responsible Lean, that whenever they sign to go to each cell, where are problems. Gemba Walk rules with the following description, as shown in Tab. 8.

Table 8 – Gemba Walk Rules

Frequency	Hierarchy	Goal
Daily	Session head	KPI (Key Performance Indicators) verification, action plan, problem solving
Weekly	Production/Quality Director	KPI (Key Performance Indicators) verification, improvement proposals
Monthly	CEO	Monitoring Projects, KPI (Key Performance Indicators) evolution verification, feedback from employees and managers

4.2.7 5S

The process was relatively easy to implement, coupled with the needed for operational improvement. All the employees got involved immediately and had clear ideas about the organization of their workstation, consequently becoming them more efficient. The simplicity of the implemented actions is inversely proportional to the gains.

4.2.8 The “5 Whys”

After the project start and with the appearance of firsts nonconformities (NC), in addition to the conventional process of their treatment, which NC is registered, it was necessary to improve the analysis of the root-causes regarding possible complex problems. A new form was created with the identification of the problems, where “5 whys” methodology is followed, trying to find the root cause of the problem. This procedure has been used two times in eight exercises.

4.2.9 Yokoten: Used to Disseminate Actions Taken in the "5Whys"

One of the tools that most catch attention was the Yokoten philosophy. "Yokoten" is a Japanese term meaning "sharing information". It is the practice of sharing "horizontally" the information amongst the different sectors, areas, and departments of the organization, such as good ideas, important practices, and solutions to problems that can be replicated. It will take advantage of the knowledge acquired or developed bypassing them systematically horizontally, so session partners do not make mistakes or apply something wrongly already tested in another working cell. The concept is to present the problem solved through the "5 whys" from one of the working cells, who worked the problem, and after becoming aware of the real root-cause, passing the corrective actions toother manufacturing cells. These analysis and actions are implemented locally, so the potential problem does not occur again (Fig. 2 as an example).

Root Cause			
Correction and Corrective Action			
Responsible			Implementation Date
Valuation of Implemented Action (Quality)			Closing Date
YOKOTEN - "Share information"			
Inicial Cell	C__	C__	C__
5 Whys' Leader Comments, if applicable			

Figure 2 – Root Cause Analysis – 5 Whys "YOKOTEN"

4.2.10 Brainstorming

Brainstorming is a dynamic group that is used as a problem-solving technique and to develop ideas or improvements in processes or products, fundamentally to stimulate creative thinking. In this sense, in the middle of January of 2019, a brainstorming session was held with cell coordinators, responsible for the productive sector and maintenance. From here, 24 proposals were signed, which were divided into 8 families. Most of the proposals were oriented towards the improvement of processes and seedlings reduction. At the end of the study, 71% of the proposals were implemented. The results can be seen in Tab. 9.

Table 9 – Brainstorming Results

No. Proposals to 21 January 2019	Group in families	Closed actions to 31 March 2019	Closed actions (%)
24	8	17	70.8%

4.3 1st Quarter Results

The KPI (Key Performance Indicators) were measured daily with the involvement of all the employees allowed to obtain the results described above, Tab. 9.

4.3.1 Productivity Rate

In all working cells, it was obtained an increase of work equal or higher than 6%, as can be seen in Tab. 10.

Table 10 – Productivity Rate

Productivity Rate	Average 2018	The goal for 1st Trimester 2019 (+5%)	Results of 1st trimester 2019
Cell 1	56.5%	61.5%	64.2% (+7.7%)
Cell 2	56.1%	61.1%	66.3% (+10.2%)
Cell 3	54.6%	59.6%	64.8% (+10.2%)
Cell 4	43.5%	48.5%	49.5% (+6.0%)
Company Average	52.7%	57.7%	61.2% (+8.5%)

4.3.2 Costs of Non-Quality (NQ)/Production Hours

With an increase of 30.2% hours of work in the first quarter, due to the inclusion of two new CNC machines, even with the change of the employees' schedules and the increase of occupation rate. It has led to an improvement in the Costs of Non-Quality (NQ)/Production Hours ratio, as shown in Tab. 11.

Table 11 – Costs of Non-Quality (NQ)/Production Hours

	The Year of 2018	(-10%) The goal for 1st Trimester 2019	1st Trimester 2019 Results
Cost of NQ/week (€)	152.25		155.10
Production Hours (h)	373		486
Ratio Costs of NQ/ Production Hours	0.408	0.367	0.319 (-27.9%)

5 CONCLUSION

Lean tools can be rapidly and easily implemented and quickly understood by the workers. The operational results were highly positive, both in the cells occupancy rate (8.5%, see Tab. 10), which was achieved just in 3 months, as well as the considerable increase of worked hours. Consequently, the ratio of costs associated with non-quality per hour decreased significantly by 27.9% (see Tab. 11). It was created an additional motivation in the employees and very satisfying results in every production and manufacturing areas. With the implementation of Lean Tools, the occupation of the machines has increased, and the defects and their costs have decreased, so the added value grows.

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