Corso di Laurea Magistrale in Ingegneria
della Produzione Industriale e dell’Innovazione Tecnologica

Tesi di Laurea Magistrale

TPM Development and Activity in Caffarel

Relatore
prof. Maurizio Schenone

Candidato
Stefano Vietti

Dicembre 2020
Table of Contents

1 Outline of Lindt & Sprüngli and Caffarel Plant ........................................ 6
   1.1 Company Outline .................................................................................. 6
       1.1.1 Brief History .................................................................................. 6
       1.1.2 Areas of Business ......................................................................... 8
   1.2 Caffarel Plant ....................................................................................... 8
       1.2.1 Brief History .................................................................................. 8
       1.2.2 Plant Layout .................................................................................. 9
       1.2.3 Size of Business ............................................................................ 10
   1.3 Production System and Production Process ........................................ 11
   1.4 Main Products ...................................................................................... 13
   1.5 Company position market share .......................................................... 16
   1.6 Date of TPM Inauguration ..................................................................... 16

2 TPM Policies and Objectives ..................................................................... 18
   2.1 Plant Overall Policies .......................................................................... 18
   2.2 TPM Policies, Objectives and Implementation .................................... 21
       2.2.1 Application of 5 Steps of KPI Management .................................. 21
       2.2.2 KPI achievement sheet .................................................................. 23

3 TPM Organization and Activities .............................................................. 26
   3.1 History of Equipment Management Organization .................................. 26
   3.2 Status of Plant Organization and Staffing by Section ........................... 29
   3.3 TPM Promotion Organization and Activities ......................................... 31

4 Focused Improvement Activities .............................................................. 33
   4.1 Outline – Aims, Goals, Concepts and Key Points of Practice .............. 33
   4.2 Structure of Losses and Analysis ......................................................... 35
       4.2.1 OEE and Machine related Losses .................................................. 36
       4.2.2 Material Losses ............................................................................ 38
       4.2.3 Labour Losses ............................................................................. 40
       4.2.4 Data collection .............................................................................. 41
       4.2.5 Analysis ....................................................................................... 44
   4.3 Kaizen Topics ....................................................................................... 47
   4.4 Focused Improvement – Examples and Effects ...................................... 51
4.4.1 Example 1: Technical efficiency improvement on Spread line ........................................ 51
4.4.2 Example 2: improvement on Labour saturation on a packing line ................................. 60
4.5 Results and Future Plans ........................................................................................................ 64

5 Autonomous Maintenance Activities ...................................................................................... 67
5.1 Outline – Aims, Goals and Concepts ....................................................................................... 67
5.2 Key Points of Activity ................................................................................................................ 72
5.3 Step-by-Step Implementation and Diagnosis Systems .......................................................... 74
5.3.1 Step 0 – 5S implementations ............................................................................................... 74
5.3.2 Step 1 – Initial Cleaning ..................................................................................................... 78
5.3.3 Step 2 – Eliminate sources of dirt and hard to clean and inspect areas ......................... 79
5.3.4 Step 3 – Create and maintain cleaning, inspection and lubrication standards ................ 81
5.3.5 Step 4 – General Inspections ............................................................................................. 83
5.3.6 Diagnosis System ................................................................................................................. 85
5.3.7 Status of each step ................................................................................................................. 88
5.3.8 Team Board ........................................................................................................................ 91
5.3.9 One-point lessons ............................................................................................................... 91
5.4 Autonomous Maintenance – Examples and Effects ............................................................... 94
5.5 Results and Future Plans ......................................................................................................... 109

6 Planned Maintenance Activities ............................................................................................... 114
6.1 Outline – Features and Issues of Equipment Maintenance ...................................................... 114
6.2 Maintenance Department Organization and Staffing .......................................................... 119
6.3 Role Sharing between Operating Department and Maintenance Group ................................ 120
6.4 Support for Autonomous Maintenance .................................................................................. 122
6.4.1 Step 1 – Initial cleaning .................................................................................................... 123
6.4.2 Step 2 – Eliminate source of dirt and hard to clean & inspection area ............................. 124
6.4.3 Step 3 – Create and maintain cleaning, inspection & lubrication standards .................. 125
6.4.4 Step 4 – General Inspection ............................................................................................. 127
6.5 Establishing Planned Maintenance System ............................................................................ 128
6.6 Maintenance Information Control, Breakdown Analysis, MTBF, MTTR, etc. .................... 131
6.7 Status of Corrective Maintenance .......................................................................................... 136
6.8 Technical Developments for Automatic Maintenance .......................................................... 137
6.9 Equipment Diagnosis Techniques, Status of Predictive Maintenance ................................ 138
6.9.1 TBM & CBM ..................................................................................................................... 138
6.9.2 Predictive Maintenance ..................................................................................................... 138
6.10 Lubrication control ................................................................................................................ 141
6.11 Stock Control.................................................................................................142
6.12 Control of Dies, Jigs, Measurement Instruments, Drawing, etc.....................145
6.13 Maintenance Budgets and Control..................................................................146
   6.13.1 How Maintenance Costs are determined................................................146
   6.13.2 How Budget are classified......................................................................147
   6.13.3 Budget Item Breakdown.........................................................................147
   6.13.4 Authority of Appropriation by Position Level............................................148
6.14 Planned Maintenance Examples and Effects..................................................148
   6.14.1 Case - Breakdowns reduction on MC0171 wrapping machine.................148
   6.14.2 Case – Heating element.........................................................................153
6.15 Results and Future Plans................................................................................156

7 Training and Education ....................................................................................160

7.1 Basic Concepts and Priority Measures.............................................................160
   7.1.1 Pillar Mission goals and main Activities.....................................................160
   7.1.2 The Training and Education Pillar Team....................................................161
   7.1.3 Pillar KPIs and KAIIs................................................................................162
7.2 Determining Training Budgets........................................................................163
7.3 Outline of training and education and methods to improve skills...................164
   7.3.1 Development and Implementation of Competencies System....................164
   7.3.2 Training Facilities....................................................................................170
7.4 Evaluation of maintenance work knowledge and skills....................................172
7.5 Qualified specialists........................................................................................173
   7.5.1 Example for Specialist of T&E Pillar – Educated Trainers.........................173
7.6 Examples of training/education materials and effects........................................175
7.7 Results achieved and Future Plans.................................................................178
   7.7.1 Future Plans.............................................................................................179

8 TPM Effects and Evaluation ............................................................................181

8.1 Tangible Effects ..............................................................................................181
   8.1.1 TPM Effect from Overall Management Viewpoints....................................181
   8.1.2 TPM Effect on Production (P)....................................................................181
   8.1.3 TPM Effect as seen from Quality (Q) Viewpoints.......................................184
   8.1.4 TPM Effect on Cost (C).............................................................................185
   8.1.5 TPM Effect on Delivery (D)........................................................................186
   8.1.6 TPM Effect on Safety (S)............................................................................187
   8.1.7 TPM Effect from Morale/Training (M) Viewpoints....................................188
8.1.8  TPM Effect on Environment viewpoints .................................................. 189
8.2  Intangible Effect.......................................................................................... 191
8.3  Issues of Present Practice and Counter-Measures................................. 191
8.4  Vision of 21st Century and their Implication for TPM.......................... 192
CHAPTER 1
Outline of Lindt & Sprüngli and Caffarel Plant
1 Outline of Lindt & Sprüngli and Caffarel Plant

1.1 Company Outline

1.1.1 Brief History

Lindt & Sprüngli is recognized as a leader in the market for premium quality chocolate, offering a large selection of products in more than 120 countries around the world. During almost 175 years of Lindt & Sprüngli's existence, it has become known as one of the most innovative and creative companies making premium chocolate.

It was the 1845 when in Zürich – Switzerland a confectioner named David Sprüngli, and his son Rudolf, decided to start a production of chocolate naming their small confectionary Sprüngli & Son. The peculiarity of this new confectionery was that, under the influence of a new Italian trend, they produced solid chocolate instead of the traditional liquid. In the rich and wealthy Zürich’s society this innovative way to produce chocolate became very popular and consequently production was transferred in from a little workshop in Zürich to a new factory in Horgen, situated on the Zürich Lake. After the death of his father in 1862, Rudolf Sprüngli took the helm of the company and boosted the business. He opened new confectioner shops and moved the factory back to Zürich. In 1870, about 80 people were working for Sprüngli. They were all employed in the production of chocolate.

In 1898, after Rudolf Sprüngli’s retirement, his son Johann started to build a new larger factory in Kilchberg, still on the Zürich lake, where the production started one year later. Since then, the company headquarters have never been moved.

In the same year, Sprüngli acquired the Bern production facilities of Rodolphe Lindt as well as the manufacturing secrets and trademark rights of the already famous Lindt brand. Rodolphe Lindt was particularly famous because he was the creator of the process called “conching”. This method, consisting of stirring the chocolate mass for several hours, could give the mass better aromas and higher quality. The extra quality chocolate produced with this new technology was called “Fondant”, “melting in mouth”, it was the first chocolate ever that melted. It soon became the new standard, giving an important contribution to the reputation of Swiss chocolate in the world.

After the acquisition in 1986 of the German distributor, in 1988 the IPO at the Swiss Stock Exchange set the base for the international expansion in the 90’s:

- 1989
  - Start-up of operations of Lindt & Sprüngli (USA) Inc. in Stratham, NH, North America
  - Integration of the French Lindt & Sprüngli SA
- 1993
  - Integration of the Italian Bulgheroni S.p.A. as Lindt & Sprüngli S.p.A.
- 1994
  - Founding of Lindt & Sprüngli (Austria) GmbH and integration of the Confiserie Hofbauer in Vienna, Austria
• 1997
  o Acquisition of the Italian Caffarel S.p.A.
  o Founding of Lindt & Sprüngli (Australia)
• 1998
  o Acquisition of Ghirardelli Chocolate Company in San Francisco
• 2014
  o Acquisition of US Candy maker Russel Stover Candies Inc.

Today, quality chocolate products by Lindt & Sprüngli are made at 12 own production sites in Europe and the USA, below in the Figure 1 is indicated their location. They are distributed by 25 subsidiary companies and branch offices, in more than 410 own stores, and also via a comprehensive network of more than 100 independent distributors around the globe. With over 14,500 employees, the Lindt & Sprüngli Group reported sales worth CHF 4.3 billion in 2018.

In the Figure 2 are shown Today brands owned by Lindt & Sprüngli.

*Figure 1: L&S Production sites*

*Figure 2: Brands owned by L&S*
1.1.2 Areas of Business

Today, the L&S Group is globally active; it develops, produces and sells chocolate products in the premium quality segment. In 2018, sales volume reached CHF 4.31 billion, continuing the yearlong growth path (Table 1).

Table 1: Sales growth of Lindt & Sprüngli

The biggest markets for the L&S Group are Europe and North America: In the global industry, the L&S Group is within the top six players with a global market share of 5.1%.

1.2 Caffarel Plant

1.2.1 Brief History

Caffarel was founded in 1826 when Pierre Paul Caffarel (1801–1871) converted an ex-tannery into a chocolate factory and invented Gianduiotto in 1852. The original plant was built in Turin, then in 1968 it has been moved in Luserna San Giovanni (TO) the homeland of its founder, the actual plant is still located there.

In 1826 Caffarel purchased a revolutionary industrial machine, invented by Bozelli of Genoa, which was able to produce more than 300 kilos a day (a record then). Thanks to this machine,
he established the first company to sell large quantities of solid chocolate (which was invented in Turin at the end of the 18th century). The second commercial success was Gianduja. In fact, in 1852 Caffarel introduced a new type of chocolate, made by mixing cocoa, sugar and “Tonda Gentile delle Langhe” hazelnuts (renowned for their taste). In 1865, he began producing this unique specialty.

In 1845 Michele Prochet joined the company and the company name became Caffarel Prochet & Co, the company's ties with the Caffarel family ended by 1897, and Prochet died in 1904. The company changed hands more than once in the early 20th century, and finally in 1997 Caffarel was acquired by the Lindt & Sprüngli Group.

**Figure 3: Caffarel plant view**

1.2.2 Plant Layout

Caffarel plant is situated in Luserna San Giovanni and it covers an area of 53.000 sqm. The plant is divided in two main production areas, the chocolate plant (8.440 sqm) and the candy plant (1.200 sqm), there are three warehouse areas for a total of 4.900 sqm, while the offices cover 2.000 sqm.
1.2.3 Size of Business

The business of Caffarel is constantly growing in the last years, particularly thank to the intercompany business that passed form a 3,8% of Caffarel business to a 53,2% (Chart 1).

For what concern the distribution channels, Caffarel has three main channels, Domestic, Export and Retail. The most important is the Domestic (mainly so called “traditional trade”: confectionaries, café and specialized stores) as it covers the 81,8%, while for the Retail at the moment, Caffarel counts only two owned shop, one in Turin and the other in Luserna San Giovanni, and this channel provides just the 2,8% of the distribution.
1.3 Production System and Production Process

The process of the chocolate follows a route of 7 steps, this process does not include the process of the roasting and the milling of the cocoa beans as from the 2001 this process had been...
reallocated to a L&S dedicated factory, located at Olten (CH), which provides the cocoa mass for all the Lindt & Sprüngli European factories.

Figure 5: Chocolate process in Caffarel

1. **Mixing the ingredients:**
   The process of the chocolate in Caffarel starts by weighing the ingredients in an automatic scale that puts the exact quantity in the mixer where they are mixed. In our plant we have two lines: one for the chocolate (shells and bars), and one for the filling masses (spread cream and fillings). Main ingredients are: cocoa mass, sugar, milk powder, cocoa butter, hazelnuts.

2. **Pre-refining and Refining:**
   After mixing the chocolate ingredients, it is necessary to refine the mass. It is a two stages process, composed by a pre-refining and then by a refining. During the pre-refining process the chocolate particles are refined at around 200 microns then, thanks to the following refining process, it is possible to reach our fineness target, which has been set at 14 microns. This process is essential, as a human being can spot the size difference if its bigger than 20 microns, and, up to a certain point, more refined the chocolate is after this process, the higher will be the quality.

3. **Conching:**
   Once the chocolate has been refined, it needs to be conched in specific equipment called conches. We have 3 conches for the chocolate line with a capacity of 4200 kg each and four conches for the filling masses line, two with a capacity of 2400 kg and two of 1800 kg. The conching is a long process which main aim is to eliminate bad tastes coming from organic acids, like acetic acid which have been developed after the harvesting process of cocoa beans. Furthermore, the conching process also aims to exalt the aromas and to make the chocolate liquid. This process could take from 6 to 20 hours.
4. **Tempering:**
   This phase of the process is one of the most delicate and important ones, because if the tempering is not done in the correct way the chocolate will lose in a rapid way its quality (fat blooming effect) and it will be also difficult to demould. The aim of this phase is to crystalize the cocoa butter in a stable form, and this is done thanks to specific equipment called tempering unit which are basically heat exchangers.

5. **Moulding:**
   After the chocolate has been tempered, then it is ready to be moulded. At Caffarel we have five main moulding lines and each one of them is specialized in a different chocolate production. We have cut products (moulded in the line Delver), chocolate with fillings (moulded on Winkler and on new Bindler line), the Easter eggs and the chocolate bars (moulded in the F.A.G.) and the Gianduiotti that have their own dedicated line.

6. **Wrapping:**
   Once moulded the chocolate is wrapped by one of our 26 wrapping machine each one of these is unique and specialized in one type of product.

7. **Packaging:**
   After the wrapping the chocolate is brought to one of our six packaging lines, where the chocolate is put in the package and then in the boxes ready to be palletized and send to the customers.

### 1.4 Main Products

Caffarel produces a wide range of product that can be grouped in different families.

- **Professional Products:**
  This category of products includes couvertures, also known as chocolate coating for professional business, as this type of chocolate is used for small business such as bakeries and restaurants. Couvertures usually have an higher fat content to make them easier to be processed by the Customers.
  In this group the other products that Caffarel make are the pastes, spreadable chocolates, sold in 5 -10 kg buckets; this product is used mainly by the bakeries to fill croissants and pastries.
• **Cut Products:**
Products with a high percentage of hazelnuts deposited onto a conveying belt and then cut. One example of this type of product is the “Piemonte”, one of our most important products in the plant; this chocolate is made by a chocolate base (milk, dark or white types), a whole T.G.T. hazelnut and then, again, a cover of the same chocolate used in the base. Once the chocolate is solidified, it is cut in different sizes.

*Figure 7: Cutted prodcut, in this category the key product is the Piemonte (top right)*

• **Moulded Products:**
Chocolate and bars with a shell that differs from the filling or inclusions. These products are put in a mould in order to make the chocolate in the desired form, particularly with this technique we produce the coverings for some products for professional business.

*Figure 8: Moulded product*
• **Spread:**
Chocolate cream made in four different recipes and put in glass jars, produced for Caffarel and for Lindt & Sprüngli intercompany. The spread is the business that in these recent years grew up the most. Caffarel is the only producer in the whole Lindt group of this product.

*Figure 9: Spread cream is the product that is growing the most in the past years*

![Spread cream](image1)

• **Candies:**
Candies and jellies produced for Caffarel and Lindt & Sprüngli intercompany. Caffarel started the production of candies and jellies in 1990, from that year this group of products is an important part of the Caffarel products portfolio.

*Figure 10: Candy and jellies*

![Candy and jellies](image2)

• **Gianduiotto:**
The Gianduiotto is the most characteristic product of Caffarel as it had been invented by Caffarel in 1865. Caffarel still produces the Gianduiotto in the very traditional way, which means extruding the chocolate instead of moulding it, this because of its high percentage of hazelnuts that make it impossible to be moulded. We produce the Gianduiotto in five different recipes: Gianduja, Dark, Orange, Coffee, Other spices.

*Figure 11: Our most famous product, the Gianduiotto*

![Gianduiotto](image3)
1.5 Company position market share

Caffarel is focusing in the premium chocolate market for specialized shops and professional activities. This is a quite tricky market where to play, because for the company it means having a big number of clients (we do not interact with super or hypermarkets) who order products in small quantity. This makes hard to have a consistent and optimized production planning and an overall production process optimization.

Thanks to the implementation of the TPM inside the company we are increasing our volumes. The volumes increase happened mainly through Lindt Intercompany business and it is helping us to spread better our indirect costs and giving us the possibility to be more competitive in the markets.

1.6 Date of TPM Inauguration

Considering the static production volume trend that Caffarel had before 2013 and a road to market becoming more challenging, the company understood that something had to be done to be more competitive in the market without losing the quality of our products. One the TPM main goals was actually to free up production capacity in order to able to get new volumes; this was strictly related with the goal of becoming more reliable and attractive for the Lindt Intercompany business, through a clear reduction of the cost of goods produced and a better service level.

At the same time the L&S Group Management decided to start a TPM program in all the plants. In September 2013 Caffarel started the TPM program starting from the foundations, 5S and PCS (Process Control System) and finally starting with the pillars activities at the beginning of 2014.
CHAPTER 2
TPM Policies and Objectives
2 TPM Policies and Objectives

2.1 Plant Overall Policies

Figure 12: Lindt & Sprüngli TPM Credo

CREDO

LINDT & SPRÜNGLI GROUP

WE ARE AN INTERNATIONAL GROUP AND ARE RECOGNIZED AS A LEADER IN THE MARKET FOR PREMIUM QUALITY CHOCOLATE
We strive for excellence to maximize worldwide market opportunities. We thoroughly understand our consumers, their habits, needs, behavior and attitudes. This understanding serves as the base to create products and services of superior quality and value. We will never make concessions that compromise our quality of product, packaging and execution.

OUR WORKING ENVIRONMENT ATTRACTS AND RETAINS THE BEST PEOPLE
We encourage, recognize and reward individual innovation, personal initiative and leadership of people throughout the organization. Respect of personal individuality, trust and fair play characterize our working relationships. Teamwork across all disciplines, business segments and geographies is a corporate requirement to create a seamless company of people who support all others for mutual success. We will develop professionals and facilitate communication and understanding across all disciplines.

OUR PARTNERSHIP WITH OUR CONSUMERS, CUSTOMERS AND SUPPLIERS IS MUTUALLY REWARDING AND PROSPEROUS
An in-depth understanding of our consumers' needs and our customers' and suppliers' objectives and strategies enables us to build a mutually rewarding and long lasting partnership.

WE WANT TO BE RECOGNIZED AS A COMPANY THAT CARES FOR THE ENVIRONMENT AND THE COMMUNITIES WE LIVE AND WORK IN
Environmental concerns play an ever increasing role in our decision making process. We respect and feel responsible for the needs of the communities in which we live in.

THE SUCCESSFUL PURSUIT OF OUR COMMITMENTS GUARANTEES OUR SHAREHOLDERS AN ATTRACTIVE LONG TERM INVESTMENT AND THE INDEPENDENCE OF OUR COMPANY
We wish to remain in control of our destiny. Independence through superior performance will allow us to maintain this control.

TPM started at Caffarel at the end of 2013. We decided to adopt this philosophy after the decision of Lindt & Springli Group to create a common credo (Figure 12) and to start this program on every plant after the very good results of TPM in Lindt Italy, that launched the program in 2010.
The program was named “Lindt Production Way (LPW)”, and Caffarel then started LPW to understand better the losses inside the plant, to optimize the cost of goods produced and to standardize the processes to avoid fluctuating results of the machines.

The need for the TPM launch depended on different factors, grouped in the Figure 13 as follows:

- **External needs**: i.e. growth volumes mainly of the Intercompany business, a competitive price market, reduction in operating profit
- **Internal needs**: the company had difficulties in meeting these demands because of the low efficiency of the production lines, there was not a culture for the improvements, and in general there was a lack of KPI’s to help on the analysis of the losses.

In order to have a good kick-off of the program, an analysis has been made to understand deeply the external needs that Caffarel was facing and the weak factors in the production area.

**Figure 13: Caffarel Background of TPM Implementation**

As a first step in the TPM, Caffarel set a Company Vision to be followed. This has been periodically reviewed and in Figure 14 it is possible to see its latest version. Now and then, the goal is to improve in all the company’s areas to be a more competitive and financially healthier company. Our company Vision is strictly related with the Lindt & Sprüngli Credo (Figure 12).
From the Company vision, the Operations impact particularly on the profitability and on the processes inside the plant, so we set our Operations Vision:

“To be passionate leaders of premium chocolate fascination from Italy by providing prime gourmet experiences and gifts to be proud of.

To become the most reliable and attractive partner for the intercompany business.

To increase the Safety in our plant and the Quality of our products”.

From the Company vision, Caffarel developed the ways that Operations could contribute to achieve those targets. This is the link between the overall company strategy, and the contribution that Operations makes to achieve those goals.

Caffarel gets direction from the global Lindt Group and this determines the Key Management Indicators (KMIs) for the upcoming years. These KMI's are typically based around sales and profit. From those broad goals, the Operations contribution outlines how Operations can contribute to sales and profit. That contribution is stratified down to the Factory Level KPIs, which are deployed into the traditional PQCDSME (Figure 15) categories and it drives the LPW pillars at Caffarel in their goal setting each year.

**Figure 14: Company Vision**

**Agenda 2024**

- 60 mio EUR NNTS
- 10% COOP

**Vision**

- Be desired by consumers for creating the finest Italian hazelnut chocolate masterpieces
- Become a financially healthy company with growing NTS & COOP

**LINDT GROUP Credo**

**Figure 15: PQCDSME**

- **P** - Productivity
- **Q** - Quality
- **C** - Cost
- **D** - Delivery
- **S** - Safety
- **M** - Morale
- **E** - Environment
2.2 TPM Policies, Objectives and Implementation

Caffarel LPW Steering Committee meets regularly (once every month) to ensure the TPM Philosophy and Activities are aligned with the Lindt & Sprüngli Group and with the company Vision. To achieve improvement strategies, the Steering Committee establishes yearly targets as Factory Level KPIs under the traditional PQCDSE categories.

The “5 Steps of KPI’s Management” are used to ensure consistency across the company vision and the process of setting objectives and implementation.

2.2.1 Application of 5 Steps of KPI Management

The 5 Steps of KPI’s Management are used to set targets and goals, highlight losses, and develop deployments to attack those losses. The impact of improvement activities is also tracked and reviewed by the Steering Committee to have a better understanding for future deployments.
The “5 Steps of KPI’s Management” are cyclically reviewed every year to ensure the effectiveness of the TPM program.
Once the KMIIs are set, every pillar defines its own KPIs and KAIs that will directly affect the plant KMIIs. This process is done yearly in order to get start the right activities to fulfil the company Vision.

After the definition of the indicators, the pillars propose to the Steering Committee the projects for the year. The Steering Committee, then, has to approve all the projects of all the pillars. This meeting, done at the beginning of the year, has the objective to prioritize the projects and to see that all the projects are well distributed in the plant to avoid that too many activities are planned in few machines making it harder to get good results.

Once the projects are approved, the Steering Committee, which meets monthly, monitors the progress of the projects. At the end of the year all the pillars close the loop on their projects comparing the results obtained with the goals set at the beginning of the year.

### 2.2.2 KPI achievement sheet

In the Chart 4 our main KPIs and the results obtained are highlighted.
## Chart 4: KPI achievement sheet

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>INDEX (Calculation Formula)</th>
<th>Unit</th>
<th>2013 TPM Kick Off</th>
<th>2019</th>
<th>Act 2020</th>
<th>Target 2020</th>
<th>Delta % 13/19</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Plant Productivity</td>
<td>kg/h produced</td>
<td>11.0</td>
<td>19.8</td>
<td>22.5</td>
<td>21.2</td>
<td>105%</td>
</tr>
<tr>
<td>P</td>
<td>OEE Mass Department</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Hazelnut Roaster</td>
<td>%</td>
<td>78</td>
<td>84</td>
<td>85</td>
<td>87</td>
<td>9%</td>
</tr>
<tr>
<td>P</td>
<td>Filling Line</td>
<td>%</td>
<td>44</td>
<td>65</td>
<td>68</td>
<td>67</td>
<td>54%</td>
</tr>
<tr>
<td>P</td>
<td>Chocolate line</td>
<td>%</td>
<td>64</td>
<td>69</td>
<td>70</td>
<td>68</td>
<td>9%</td>
</tr>
<tr>
<td>P</td>
<td>OEE Moulding Department</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Delver</td>
<td>%</td>
<td>63</td>
<td>64</td>
<td>66</td>
<td>65</td>
<td>5%</td>
</tr>
<tr>
<td>P</td>
<td>Winkler &amp; Dunnebier</td>
<td>%</td>
<td>63</td>
<td>65</td>
<td>62</td>
<td>65</td>
<td>-2%</td>
</tr>
<tr>
<td>P</td>
<td>Spread Line</td>
<td>%</td>
<td>80</td>
<td>75</td>
<td>81</td>
<td>75</td>
<td>16%</td>
</tr>
<tr>
<td>P</td>
<td>OEE Wrapping/packing Department</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Wrapping machine AC0332</td>
<td>%</td>
<td>75</td>
<td>81</td>
<td>83</td>
<td>83</td>
<td>5%</td>
</tr>
<tr>
<td>P</td>
<td>Wrapping machine AC0790</td>
<td>%</td>
<td>62</td>
<td>74</td>
<td>73</td>
<td>75</td>
<td>18%</td>
</tr>
<tr>
<td>P</td>
<td>Jointech-FIMA</td>
<td>%</td>
<td>50</td>
<td>73</td>
<td>73</td>
<td>77</td>
<td>30%</td>
</tr>
<tr>
<td>Q</td>
<td>Waste of production</td>
<td>%</td>
<td>1.6</td>
<td>1.8</td>
<td>1.1</td>
<td>1.7</td>
<td>-35%</td>
</tr>
<tr>
<td>Q</td>
<td>Rework</td>
<td>%</td>
<td>2.6</td>
<td>3.1</td>
<td>2.3</td>
<td>3.9</td>
<td>-10%</td>
</tr>
<tr>
<td>Q</td>
<td>Number of total Complaints per 1000 tons molded</td>
<td>%/1000 tons</td>
<td>11.8</td>
<td>16</td>
<td>20</td>
<td>42</td>
<td>-79%</td>
</tr>
<tr>
<td>Q</td>
<td>Number of Non-conformities per 1000 tons molded</td>
<td>%/1000 tons</td>
<td>119**</td>
<td>158</td>
<td>173</td>
<td>139</td>
<td>-49%</td>
</tr>
<tr>
<td>C</td>
<td>Direct labour cost</td>
<td>€/ton produced</td>
<td>2.229</td>
<td>1.313</td>
<td>1.231</td>
<td>1.300</td>
<td>-45%</td>
</tr>
<tr>
<td>C</td>
<td>Indirect cost</td>
<td>€/ton produced</td>
<td>2.953</td>
<td>1.770</td>
<td>1.690</td>
<td>1.750</td>
<td>-43%</td>
</tr>
<tr>
<td>D</td>
<td>Case Fill Rate</td>
<td>%</td>
<td>98.6**</td>
<td>99.0</td>
<td>99.5</td>
<td>100</td>
<td>1%</td>
</tr>
<tr>
<td>D</td>
<td>3rd party on time / in full</td>
<td>%</td>
<td>73.7***</td>
<td>80.7</td>
<td>84.5</td>
<td>85</td>
<td>15%</td>
</tr>
<tr>
<td>S</td>
<td>Lost time accidents (requiring days off working)</td>
<td>%/3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>-100%</td>
</tr>
<tr>
<td>S</td>
<td>First Aid (not requiring days off working)</td>
<td>%/3</td>
<td>21</td>
<td>23</td>
<td>5</td>
<td>20</td>
<td>-76%</td>
</tr>
<tr>
<td>M</td>
<td>Sick leave</td>
<td>%</td>
<td>4.7</td>
<td>5.1</td>
<td>2.7</td>
<td>4.2</td>
<td>-43%</td>
</tr>
<tr>
<td>M</td>
<td>Turnover rate Operations</td>
<td>%</td>
<td>7.0</td>
<td>6.9</td>
<td>5.3</td>
<td>6.8</td>
<td>-24%</td>
</tr>
<tr>
<td>E</td>
<td>Water Consumption</td>
<td>m3/ton produced</td>
<td>2.0</td>
<td>1.1</td>
<td>0.8</td>
<td>1.2</td>
<td>-59%</td>
</tr>
<tr>
<td>E</td>
<td>Energy Consumption</td>
<td>MWh/ton produced</td>
<td>3.4</td>
<td>2.3</td>
<td>2.3</td>
<td>2.4</td>
<td>-33%</td>
</tr>
</tbody>
</table>
CHAPTER 3
TPM Organization and Activities
3  TPM Organization and Activities

3.1  History of Equipment Management Organization

As mentioned in the Chapter 2, it was clear to our management that we needed to do something to face our internal and external issues, and, as the LPW was starting as a Group methodology, Caffarel decided to start it right away in order to be more structured for the company and group needs.

It was 2013 when the first steps in the TPM were moved. As first thing, we started to build the foundations of the TPM implementing the 5S activities inside the plant. The 5S started with the pilot projects on wrapping machines.

Seiri: Sorting out things not needed created a lot of free space

Seiton: Straighten out tools and parts left a visible impact

Seiso: Cleaning has always been crucial for us as a food manufacturer

Seiketsu: The operators set their own standards to reduce non-added activities such as searching

Shitsuke: Self-audits would help the operators to sustain the achievements and even improve their standards

Figure 19: Shadow board for tools and standards for the floor lines
The results were very positive, so the activities of 5S were expanded to other machines and to other departments.

At the same time a reliable Performance Control System (PCS) had to be set to bring consistency to the TPM program. Before the TPM, the production lines’ efficiencies were analysed too but the process behind was confused, not structured and embedded in all the Operations area. For example, functions as Maintenance and Planning were rarely being involved. To build a reliable PCS, performance boards were installed in order to discuss the performances at the shift handover and at the daily meetings. This system of analysis brought a huge benefit to Caffarel because before people did not know how the performances were and consequently there was no improvement attitude at shop-floor level. Furthermore, in order to tackle quickly the plant problems, we set an escalation system to better manage the problems, having all the interested functions present to take the decisions. With our PCS, we improved our understanding of the performances of the plant and our analysis of the root causes of bad performances, improving the effectiveness and the efficiency of the solving actions.

### Figure 20: Checklist to evaluate 5S in the plant

<table>
<thead>
<tr>
<th>Area</th>
<th>Point to Check</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Document</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checklists are clear and easy to read and understand</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Checklists are clear and easy to read and understand for operators, supervisors, managers, and other</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is easy to move scissors, all scissors are close</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Machines</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All machines can be identified easily</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Material/Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is easy to move materials and equipment easily</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Pavement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The floor is clean and in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All scissors and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All materials can be moved easily and quickly</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Tools &amp; Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All tools and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Fronts of Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The fronts of equipment are clear and easy to read</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Standard &amp; Origin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standard and origin are clear and understandable</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All scissors and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Office of Reparto</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The office of the department is clear and understandable</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>5S Board</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The 5S action plan is updated and visible in the 5S board</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All materials are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Atrezzature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All tools and equipment are in good condition and are close to where they are used</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Pavimento</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The floor is clean and in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All scissors and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Material/Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is easy to move materials and equipment easily</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Pavement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The floor is clean and in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All scissors and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All materials are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Tavoli e Scrivanie</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All tables and desks are clean and in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Atrezzature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All tools and equipment are clean and in good condition and there are no broken or non-repaired</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Fonzi di Sporco</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The areas of dirt are clear and understandable</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Standard &amp; Origin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standard and origin are clear and understandable</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Scissors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All scissors and equipment are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Office of Reparto</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The office of the department is clear and understandable</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>5S Board</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The 5S action plan is updated and visible in the 5S board</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All materials are in good condition</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Atrezzature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All tools and equipment are in good condition and are close to where they are used</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

The results were very positive, so the activities of 5S were expanded to other machines and to other departments.
After the successful implementation of the TPM foundations we started the roll-out of all the eight pillars:

- Autonomous Maintenance (AM): 2014
- Focused Improvement (FI): 2014
- Planned Maintenance (PM): 2014
- Safety (S): 2014
- Progressive Quality (PQ): 2017
- Early Equipment Management (EEM): 2018
- Training & Education (T&E): 2018
- TPM Office (TPMO): 2019

Every pillar started defining their own mission (linked to the plant vision), KPIs, their member’s role as well as defining a Master Plan. Above all, they started to launch kaizen activities.

Since the TPM program started, more than 100 Major and Standard Kaizen have been launched.
3.2 Status of Plant Organization and Staffing by Section

The Lindt Production Way is structured as a temple (Figure 23) founded over the PCS and the 5S foundations and supported by eight pillars.

Figure 23: Caffarel TPM temple
The organization of the LPW program is strictly linked to the company Structure

Figure 24: Link between Company structure and LPW program

The Steering Committee was established in 2016. Each pillar leader has a seat on the Steering Committee, as well as LPW department representative, the Vice President of Operations, and the Quality Director too.

The Steering Committee oversees the progression of LPW activities and is responsible for:

- Checking the status of the eight pillars and providing support when needed
- Confirming the improvement projects/activities proposed by pillars
- Verifying the results of the projects/activities by monitoring and tracking results

The Steering Committee meets monthly, applying a standard meeting agenda which focuses on defined topics for each pillar:

- Open topic discussion
- Active project evaluation, discussion of possible issues
- Closed Projects (evaluation of the KPI results)
- Planned Projects (first Steering Committee of the year)
- Loss eradication examples
- Pillar Progress (Master Plan)
3.3 TPM Promotion Organization and Activities

As our LPW program matured, we understood that we needed to communicate effectively to our organization to encourage participation and excel in performance. The communication was meant to support our efforts, encourage involvement and inform all the employees about evolutions and adaptions of the LPW program.

Our goal is to involve not only few people in the TPM activities but to make all the plant people aware about the utility of TPM. We do know that to have a real impact on the performances, it is crucial we push everybody towards the same direction; this is why we always encourage employees to put in place their ideas to work in a better environment, through building a real Continuous Improvement attitude.

To verify the involvement of employees in the TPM activities we monitor the trend of Kaizen submitted and the suggestions proposed. Since the start of LPW, we see that the involvement of operators in the TPM activities is growing constantly.
CHAPTER 4

Focused Improvement
4 Focused Improvement Activities

4.1 Outline – Aims, Goals, Concepts and Key Points of Practice

The Focused Improvement Pillar, as all the other Pillars, supports the factory to achieve long term strategic objectives. Its mission is to “Check, analyse and attack machine, material and labour losses to improve the productivity, the efficiency and to reduce the cost of good”.

In this sense, our vision is a zero-loss production, encouraging every production operator to work, on a daily basis, tackling any kind of losses. To achieve this, we work through a proper and effective loss intelligence, loss eradication and loss prevention, using the right measures.

Therefore, FI is in charge of providing a strategy to identify operational losses, to measure and to consequently to tackle them. In addition, FI provides the Improvement Plan, created together with the other pillars, and it is responsible to follow up the results of improvement teams’ activities.

The FI pillar is a cross-functional team composed by five people, shown in Figure 25, led by Danilo Colletta who is also the Plant TPM Coordinator.

The pillar consists of employees working in the Industrial Performance office, the Production & Planning office and the Industrial Controlling department who meet twice a month.

The FI pillar follows the methodology summarized in the route shown in Figure 26, which is based on six steps:

- **In Step 1**, we define the vision and targets for our key performance indicators and our production volumes, monitoring the planning cycle and checking the execution and the results.
- **In Step 2**, we track and tackle machine losses, mainly change-overs time, and material losses.
- **In Steps 3-5**, we concentrate on reducing labour losses.
- **In Step 6**, we extend the existing control systems and develop tools for a system to hold the gains.
Below in the Figure 27 is presented our master plan showing the route steps since the start of the pillar; in green are the steps done, while in blue the planned ones.

The structure of Indicators that FI takes into account in order to evaluate production outputs have been divided into KPIs (Key Performance Indicators) and KAI's (Key Activities Indicators), linking them with the traditional logic of PQCDSME.

Below in Table 2 and Table 3, it is represented the whole list of the FI Indicators.
4.2 Structure of Losses and Analysis

The FI Pillar, led by the goal to support the achievement of business results, takes into account production costs, whose breakdown is shown in Chart 7. Specifically, the pillar works to reduce material costs (raw materials and packaging materials) and labor cost.

In order to tackle the losses in a focused way, it has been defined to split them in three categories:

- Machine losses
- Material losses
- Labor losses
4.2.1 OEE and Machine related Losses

Regarding machine-related losses, the pillar analyzes the OEE losses by focusing on the production lines having the higher utilization.

The OEE Losses are divided into several families grouped into two categories: planned losses and unplanned losses, as it is shown in the Chart 8 below.

![Chart 8: OEE Losses Deployment example of Spread Line](image-url)
• **Planned losses:**
  
  o **Planned Maintenance**: is a planned shutdown for maintenance activities done to keep or restore the equipment in the best conditions to perform at its best.
  
  o **Cleaning**: refers to a planned shutdown when the equipment is cleaned up to ensure best quality, food safety and working conditions. Cleaning between shifts and at the end of production is also included.
  
  o **Changeover**: is to a planned shutdown when the equipment configuration is changed to switch from one product to another.
  
  o **Break and Training & Meetings**: refers to a planned equipment shutdown due to a break of the operator(s), linked – for example – to meals or shift handovers if there is no crew overlapping. Training & Meetings refer to a planned equipment shutdown due to training activities, PCS meetings, Pillar/Kaizen activities.
  
  o **Start-up**: represents the activities connected with the preparation and ramp-up before production starts. It starts when the crew (or part of it) begins with the preparation activities and it ends when the first product, with the right quality (according to specifications), has been produced; similarly **Shut-down** represents the activities connected with the run-out of the equipment. It starts when the equipment produces the last product and it ends when the crew leaves the workplace, that is, when the equipment is again available for production.
  
  o **Trial and test-run**: refers to a timeframe when the equipment is producing non-sellable products (e.g.: for R&D or QA purposes) or running for process tests (e.g.: for engineering purposes).

• **Unplanned losses:**
  
  o **External stops**: refer to equipment stoppages due to lack of resources (e.g.: manning, energy, material) or because of downstream process(es) issues. In both cases, the reason comes from outside the perimeter of the equipment. As examples: a moulding line which starves due to lack of mass upstream or a mass line which is blocked due to full tanks downstream.
  
  o **Breakdowns**: is an unplanned stop which happens during the line production runtime and which implies the intervention of a maintenance technician and the repairing or restoration of a component.
  
  o **Stop and short stops**: are unplanned stops which are not a Breakdown but requiring actions on conditions / parameters of the component(s) (example: sensor stops detecting (it’s dirty) -> sensor has to be cleaned up)
  
  o **Defect losses, material waste & rework**: is the time spent by the equipment producing non-conform products “first time right”.
  
  o **Speed losses**: are due to a gap between the working actual speed (punctual speed) and the nominal speed. Such a gap can be caused to any of the following issues (or a combination of them):
    
    ▪ Technological (e.g. viscosity, tempering, cooling)
    ▪ Reduced speed due to technical problems / equipment worn-out
    ▪ Reduced speed due to quality problems
    ▪ Reduced speed due to variances from ideal crew

The FI pillar makes the data intelligence related to OEE losses, then other different losses are shared with the pillars of appropriate competence:
• **FI:**
  - Start-up and shut-downs;
  - Changeovers;
  - Defect losses (rework and waste).
• **PM:**
  - Speed losses;
  - Breakdowns.
• **AM:**
  - Short stops:
  - Cleanings.

### 4.2.2 Material Losses

The second loss category that the FI pillar analyses and attacks is represented by the material losses; specifically, the pillar focuses on the chocolate losses caused during production.

First of all, the pillar starts making deployments on material losses in order to identify where losses are, below in Chart 9 is possible to see the percentage of the total amount of material losses compared to good production.

The percentage of material losses is then deployed into the different loss modes, which is shown in Chart 10.

*Chart 9: Material Losses*
The further deployments are done by type of material loss (rework, waste, overweight and second quality) per machine and per product. This is explained hereafter using an example.

In Chart 11 is possible to see the chocolate waste deployment which shows the percentage of scrap per each production line and its impact on the total amount of plant scrap.

After this analysis, the further deployment is done per every product of each production line, see Chart 12 below where the waste of line “MC0521” (orange bar in Chart 11) is deployed: the different “bars” represent every different product produced on that line. This is done to evaluate which kind of initiative has to be launched to reduce the total company scrap.
4.2.3 Labour Losses

Chart 13: Labour deployment

Labor Deployment and Labour Losses (H) - 2019

- Total Paid working Hours: 381,485
- Total productive working hours: 272,856
- Paid leave: 62,503
- Total absent: 34,536
- Direct labor Support...
- Organisational Losses: 17,649
- Ideal OEE & Standard direct labor crew: 131,855
- OEE Losses & Standard direct labor crew...
- Ideal OEE & Ideal direct labor crew (VA, SVA): NVA
- Crew Insaturation

Labor Hours: 0, 50,000, 100,000, 150,000, 200,000, 250,000, 300,000, 350,000
The third loss category that the FI pillar deals with are labour related losses, in the Chart 13 is shown how, at Caffarel, we classify the labour hours, splitting them in several categories.

The different name showed in the previous chart have the following meaning:

- **Total Paid working Hours**: this represent the total amount of labour hours that the company pays considering the total numbers of blue-collar workers;
- **Paid Leave**: there are the hours paid but not worked due to vacations days
- **Total absenteeism**: this represent the amount of not worked hours due to sick leaves, maternity leaves, unions meetings, occupational accidents;
- **Public holidays**: there are the hours paid but not worked due to public holidays;
- **Total productive working hours**: this the difference between the total paid working hours and the previous three labour hours categories.

The FI pillar is not currently working on paid leave, total absenteeism and public holiday but it is concentrated on Total productive working hours which is deployed as follows:

- **Extra manning**: this represents additional people on the line on top of the standard direct labour crew
- **Organizational losses**: this is represented by breaks during production shifts, shift changes;
- **Direct labour support**: this are labour hours spent to do indirect tasks like internal transportations, coordination activities, trainings, etc.;
- **Total worked Actual OEE & Standard Direct labour crew**: this are direct labour hours spent on production lines which have performed at their actual OEE’s;
- **OEE losses and Standard direct labour crew**: this represents labour hours lost due to OEE losses;
- **Ideal OEE and Standard direct labour crew**: this is the ideal labour hours we should have spent if we hadn’t had any OEE loss;
- **NVA Activities and Crew Unsaturation**: this represents labour hours spent to work on not value-added activities or hours lost due to a not ideal saturation of the crew. We still have to introduce the analysis of these kind of labour losses;
- **Ideal OEE and Ideal direct labour crew (VA, SVA)**: this is the theoretical labour hours we could have spent if we hadn’t had neither OEE losses nor NVA and crew unsaturation;

### 4.2.4 Data collection

The data needed to perform the analysis, deployments and losses intelligence are collected in some case manually and in others are automatically registered.

For instance, all information related to the consumption of materials (raw and packaging materials) are collected in our ERP (Enterprise Resource Planning) SAP while data related to labour hours spent on production lines are entirely manually collected (each head of line has the responsibility to fill out a specific paper form).

Data related to machine hours and machine losses are collected in two different way depending on the line:
Automatically:

On some production lines we have installed a MES (Manufacturing Execution System) which allows to automatically collect data related to the production orders. We can therefore track the info related to the OEE’s planned and unplanned losses as described in the previous section 4.2.1.

Production lines working with the MES have a dedicated PC with the MES software installed. It shows all data concerning the active production order, the average and punctual speed of the line as well.

When a break occurs, the Production Operator must justify the related cause by selecting the right one from a list, this is necessary to have every stoppage detail. At the end of every production shift the operator registers also the amount of waste and rework that have been produced during the shift.

At the moment, the MES System has been implemented in main moulding lines and in some wrapping machines with the higher utilizations.

Below in Figure 28 and in Figure 29 two examples of the MES software screenshot are shown.

Figure 28: MES Line pc screen

Figure 29: MES efficiency check screen
• **Manually:**
  In the production lines where we still not have a MES, data are collected by the operators on a paper form, see below an example in Table 4.

**Table 4: Example of paper form use to production data collection**

<table>
<thead>
<tr>
<th>Report di Produzione</th>
</tr>
</thead>
<tbody>
<tr>
<td>N° Data</td>
</tr>
<tr>
<td>--------</td>
</tr>
</tbody>
</table>

Nella tabella sottostante indicare la **durata in minuti** dei fermi per ciascuna causa.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Tempi con intervento manutenzione</th>
<th>Problem Solving: compilare la sezione sotto analizzando il problema principale del turno</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Guasto con intervento manutenzione</td>
<td>Che cosa è successo? Perché? Autone interessa</td>
</tr>
<tr>
<td></td>
<td>Problem Solving:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi Temperatrici</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi Calore /taglietti</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Palaio manutenzione durante RT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi Sigla</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi elettrici</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi sensibili</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interferenze (problemi elettrici)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi deposizione contemporanea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi manipolatori</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi planetari/cen trifoglie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problemi taglierino</td>
<td></td>
</tr>
</tbody>
</table>

The info collected on the paper form showed before are then filled in a digital form based on a excel file and recorded in our PCS (Performance Control System). Below in Table 5 is shown an example of digital sheet.
Table 5: Excel sheet to collect machine hours and losses

4.2.5 Analysis

The system applied for the losses analysis is called PCS (Performance Control System).

The PCS is our system of tools, organizational procedures and practices which aim together to:

- structure the meetings in order to make them effective, involving everybody;
- check performances through the KPIs;
- identify, analyze and solve problems in real time through the involvement of everyone.

We have four levels of PCS as is shown in Figure 30:

Figure 30: PCS meetings escalation
• **PCS Department meeting:**

PCS Department meeting has a standard board, shown in *Figure 31*, that has to be filled out by the attendees. Every topic is analysed and the decision concerning how to deal with the problems (especially if there is necessity to perform an escalation) is taken. The order of indicators is:

- Safety: N° of Lost Time Accidents, N° of First Aids; N° of Near misses, N° of Unsafe Conditions;
- Quality: n° of Non-Conformities;
- Productivity and Cost: Technical Efficiency, % Rework, % Waste, % Packaging waste;
- Delivery: Alignment to the production plan.

![Figure 31: PCS Department board](image)

• **PCS Factory Daily meeting:**

PCS “Daily” has standard boards within the PCS Room, below in *Figure 32*, it is shown a panoramic picture of the PCS Daily meeting room. The indicators are the same as PCS “Line” meeting with the aggregation of the data at a daily level. The decision-making process has improved a lot, as we have concrete figures to lead processes and not just impressions. PCS “Daily” acts as our control room and allows us to take immediate decisions which can include the creation of small teams aiming at implementing actions in the Gemba.

Open points are managed with an action plan in which we decide the actions and we name a responsible. The day after the identification of the problem, we check it. If it has not been solved, we start a more detailed analysis. If necessary, we go further ahead through escalating the issue to the “Weekly Meeting”

![Figure 32: PCS Daily meeting room](image)
• **PCS Weekly meeting:**
The weekly meeting takes place every Wednesday and lasts around 1 h. The participants indicated in Figure 30 follow a specific agenda, see Table 6, concerning detailed topic related to safety, quality, cost and performance and maintenance. We then set an action plan to track actions defined at this level of meeting or actions coming from the escalation processes on previous meetings.

• **Monthly meeting:**
This is the last level of PCS escalation meetings and is mainly done to recap the overall performances related to different drivers linked to the traditional logic of PQCDSME.

### Table 6: Weekly meeting Agenda

<table>
<thead>
<tr>
<th>Driver</th>
<th>Topic</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>N° STOP OBSERVATIONS</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>STOP AUDITS PERFORMED VS. PLANNED</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>STOP AUDITORS PERFORMANCES</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>NEAR MISSES</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>NEAR MISSES WITH WORK ORDER</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>N° ACCIDENTS</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>Intercompany and Customers Claims</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td>Internal Claims</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td>Food Safety</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>Orders Collection</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td>Campaign Trend</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC</td>
<td>Caffarel Intercompany Volumes</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Technical Efficiency</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>SEE</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>Rework and Scraps</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hours deviation from standard</td>
<td>Week</td>
</tr>
<tr>
<td></td>
<td>Productivity</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5S Audit Trend in Production Department</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Maintenance intervention</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td>% P maint / H run time</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td>Breakdown analysis</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caffarel Operation Action plan</td>
<td>Month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Every Wednesday</td>
<td>Total Duration (min)</td>
<td>60  70</td>
</tr>
</tbody>
</table>
4.3 Kaizen Topics

In relation to Kaizen topic, we manage four levels of improvement initiatives based on problem solving approach:

- Suggestion
- Quick Kaizen
- Standard Kaizen
- Major Kaizen

The Figure 33 shows the four different levels of Kaizen highlighting when they are applied and who is involved in their related process.

![Figure 33: Types of Kaizen initiatives](image)

In order to be incisive, accurate in terms of time and in line with the methodology, we started to teach the approach, the path to follow and the techniques to our key people in the factory. This should be considered one of the milestones of our TPM experience because it contributed significantly to the Continuous Improvement approach, heavily impacting on people’s attitude and mindset.

We trained all the operators on what a suggestion is and how to issue one. For what is related to Quick Kaizen we launched, in middle of 2018, a Quick Kaizen Challenge whose aim has been to push and stimulate the operators to issue effective improvements using the right problem-solving tools; up to now 60 people have been trained and involved in the Quick Kaizen delivering process. We still have to work on Standard Kaizens and Major Kaizens since operators able to autonomously manage this kind of Kaizen are fewer.
Following some details on each Kaizen level mentioned before in Figure 33:

- **Suggestion**: could be a solution for a basic problem or could be an ordinary improvement. The formalization required is the compilation of a form similar to standard tags show in Figure 35.

  ![Suggestion form](image)

- **Quick Kaizen**: could be a solution for a problem that requires more analysis but that does not usually require the involvement of interfunctional teams. It could be an improvement that does not require deep and specialist knowledge. The route followed is PDCA. Standard tools such as 5 Why’s or Ishikawa diagram are usually adopted, an example is shown in Figure 36. It is always strongly recommended to draw a sketch of the idea proposed and to do a rough calculation of the saving (for this purpose, an excel sheet with the most common drivers for the costs is available; if the calculation requires more complex operations, Industrial Performance and/or Controlling can help).
### Standard Kaizen

Could be a solution for a deeper, chronic problem that requires specific knowledge passing through an interfunctional team. Route is, as usual, the PDCA and tools adopted are the standard ones as well (e.g. 5 Why’s, Ishikawa diagram, etc.).

### Major Kaizen

Usually stems from a Pillar initiative, it is assigned to a team working with the appropriate route, following step by step the methodology. One Example is shown in the next paragraph.

Below in Chart 14 is the number of kaizen initiative done till the TPM program kick-off.
In the Chart 15 and Chart 16 the trends of Suggestions and Quick Kaizen are shown. Until 2020 the two trends were mostly positives then in 2020 due to the Covid-19 situation we had a little step back.
4.4 Focused Improvement – Examples and Effects

4.4.1 Example 1: Technical efficiency improvement on Spread line

Problem Identification:
The Spread line is one of the plant’s most utilized lines and furthermore it is the only Spread line of the Lindt Group; we produce three different spread creams recipes for Caffarel and for Lindt as well.

Figure 38: Caffarel and Lindt spread cream
As it is possible to see in Chart 17 the volumes are continuously growing and consequently the utilization of this production line grows too, as is shown in Chart 18.

**Chart 17: Spread volumes trend**

**Chart 18: Spread Line utilization trend**

For the reason described before and consequently to increase the capacity of this line and reduce the transformation cost, the FI pillar has decided to launch a project to increase the technical efficiency analysing and attacking its main causes of loss.

As is possible to see the main inefficiencies were represented by short stops and speed losses. The team started to focus on them.
Team:

The team working on this project had been a cross functional team and composed as follow: one member of the Industrial performance area, two Line heads and two maintenance technicians, as shown in Figure 39:

Figure 39: FI project team

Target setting:

The target to be reached was to increase the technical efficiency of ten points, meaning to increase the efficiency of 13% passing from 77,8% to 87,8% of technical efficiency as in shown in Chart 20.
Initiatives on Short stops

Analysis:

The team analysed the type and frequency of the short stops collected through the MES line software, see Chart 21; it has then been analysed where the stops happened Chart 22.
After this initial data analysis, it was found that 40 different stops happened, roughly having a frequency of 70 stops every 100 h of runtime.

The team decided to analyse the short stops representing the 80% of the total number using a specific format which provides for the use of the 5Whys tool.

**Actions:**

After a deep analysis of the short stops mentioned before, 24 different improving actions had been defined. Mostly of them were represented by physical interventions on the machine, now we present some examples in detail:

- There were different problems on the application of the seal causing stops in runtime. One of the causes was identified in the type of pneumatic piston (*Figure 40*) which stops the glass jar before the seal placing. It was possible to dramatically reduce the frequency of this stop changing the type of piston and its position.

*Figure 40: Pneumatic piston for seal applying*
• Another frequent stop was related to the fact that the line had to be stopped to remove the empty labels reel. To solve this problem it has been installed a wider reel support (Figure 41) which allowed to remarkably reduce the impact of this type of stop since we more than doubled the number of labels on every reel.

Figure 41: Transparent support of the empty label support

• Another example is represented by the jar advancement guides in the seal application area, because they did not have a clear fixed positioning and could be handled with the risk of having a random jar positioning while receiving the seal. We fixed the guides in a way to make impossible any not proper adjustment allowing to significantly reduce the stops in this area

Results:

After the application of several improvement actions, we recorded impressive results on short stops frequency. The numbers of short stops passed from 70 stops every 100 h of runtime to 27 stops, see below Chart 23.

Chart 23: Short stops frequency (after Improvements)
**Initiatives on Speed Losses**

**Analysis and actions:**

Relatively to speed losses, through the use of the MES it was first checked at what speed the previous weeks’ production runs was.

The nominal speed of the line was 22 jars per minute but it was possible to discover that in reality, due to speed variations, the average speed was just 18 pieces per minute, see **Chart 24**.

**Chart 24: Speed trend (before Improvements)**

![Speed Trend Chart](chart.png)

It was then verified which was the bottleneck element of the line determining the speed, see below **Figure 42**.

**Figure 42: Line layout and bottlenecking machine**

![Line Layout and Bottleneck](figure.png)
1. After doing some observations, it was found that the first station limiting the speed was the depositing station. The causes of this limit were analyzed in detail through a 5 Why’s analysis and it was defined that it was depending on 2 main factors. The cause of these problems had been solved and this station was no longer acting anymore as the line bottleneck.

2. After having solved the problem on the depositing station, it was found that the bottleneck had moved from the depositor to the caps’ placer machine. Also here the causes had been analyzed and it was found that the element speed was depending on its motor’s inverter frequency. We acted on the unit motor’s inverter increasing the operating Hz, adjusting therefore the speed and allowing it to have enough time to place the caps of the jars arriving from the upstream station.

3. Finally, having adjusted the speeds of the previous two stations, the bottleneck had moved from the caps’ placer unit to the seal and label application station. The causes had been analyzed and it was found that this was depending on the fact that the operating parameters were not optimized and that there were no standards to process different recipes. Some parameters were subsequently optimized and reference recipes were defined, making possible to increase the overall speed of the line.

To solve the problem of speed losses, 9 different actions had been implemented, some of them mentioned before.

**Results:**

Thanks to these improvements, as can be seen in *Chart 25*, the speed raised up from 18 jars per minute to 22.

*Chart 25: Speed trend (after Improvements)*
Overall, the improvement measures adopted by the team, allowed to increase the technical efficiency in runtime of 15.3%, exceeding the initially defined target as visible in Chart 26.

Chart 26: Final Results

Technical Efficiency - Spread

Before 77.8%  After the team 93.1%
4.4.2 Example 2: improvement on Labour saturation on a packing line

Problem definition:
The packing line Jointech-FIMA is one of the most utilized line in the packaging department. On this line we pack bars and tablets. Packaging style is the flow-pack one.

*Figure 43: Products packed in the Jointech - FIMA line*

From 7 to 11 people work on this line and the production of the bars there is continuously increasing year by year.

Below in *Figure 44* is shown the line layout indicating the position of the nine operators who work during the production of snacks and bars (product examined in this kaizen).

*Figure 44: Line layout and people stations (before improvement)*

The operators did the following activities:
- Op.1: is the head of the line and manages the flow-pack machine;
- Op.2 and op.3: are in charge of the machine products feeding;
- Op.4: is the one who helps the operator 2 and 3 making them available to have always the chocolate bars ready to be fed into the machine;
- Op. 5, 6, 7, 8: are responsible to pick the flow-packed bars, to place them into a display of 24 pieces and then to insert this display in an outer case;
- Op.9: is in charge to close the outer case through a taping machine and to apply the product’s label on the case side.

**Target Definition:**

The target the FI pillar had set, was to improve the labour productivity (how many products can be produced for each labour hour spent) by 10%.

**Analysis:**

The improvement initiative has been realized following the PDCA approach formalized in a Standard Kaizen as shown in **Figure 45**.

![Standard Kaizen on a packing line](image)

In order to analyse the saturation of the labor crew, the pillar decide to apply the work sampling tool. The dimension of the sample has been defined following this formula:

\[ N = \frac{4 \times (1 - p)}{r^2 \times p} \]

- \( N \) = Number of observations
- \( p \) = initial estimated probability
- \( r \) = accepted relative errors

Considering to have an initial estimated probability to find unsaturated people \((p)\) of 70% and a relative error of 10% \((r)\), the number of observations required was 170. The team performed 220 observations.
The observations done following the work sampling method, consisted of tracking what every single line operator was doing at the moment of the observation. We tracked the position of each single worker and if it was doing a Value-added activity (VA), a Not Value-added activity (NVA) or a Semi-Value-added activity (SVA).

After the period of observations, we obtained the results shown below.

In Chart 27 is shown the number of workers divided by the kind of activity: VA, NVA, SVA.

*Chart 27: activities done by the operator of Jointech-FIMA line*

![Chart 27](chart.png)

In Chart 28 is shown the kind of activities done by the operators, VA in green, SVA in orange and NVA in red.
It was possible to understand that the main percentage of unsaturation was concentrated on the last three operators of the line, who were in charge of the final packing (flow-packed bars placing into the display and then display placing in the outer case).

**Actions:**

After the observation, as it is possible to see in Chart 29, it was noticed that the higher percentage of unsaturation was on operators 8, 9.

**Chart 29: Percentage of saturation per workplace**

<table>
<thead>
<tr>
<th>AREA</th>
<th>0%</th>
<th>20%</th>
<th>40%</th>
<th>60%</th>
<th>80%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controllo macchina (CAPOLINEA)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>gestione pedane semi-lavorati</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Alimentazione semi-lavorato a macchina</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Alimentazione semi-lavorato a macchina</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Inserimento prodotto in espositore</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Inserimento prodotto in espositore</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Inserimento prodotto in espositore</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Imballaggio</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Legend: VA, SVA, NVA, Operators, Measured Operators
The operator 8, preceded by 3 operators doing the same task, received a number of flow-packed bars to be inserted in the display which was not enough to make him/her adequately saturated. The operator 9, at the max speed the line was able to work, didn’t have to do so many operations at a frequency to make him/her saturated.

For this reason, it was decided to take out off the line the operator 8 and to arrange in his/her workplace the operator 9. In this way the saturation of the operators 5, 6 and 7 increased a little bit, while the operator 9 became responsible to pack some bars that can’t be picked by the previous operators keeping anyway the task to close the outer cases and feeding them in the taping machine before applying the product’s labels on the cases.

In is shown the layout of the line which indicate the position of the eight operators who work during the production of bars.

Figure 46: Line layout and people stations (after improvement)

Results:

After the improvements, the new work place positions had been tested checking the line productivity. With this new configuration the speed of the line remained unchanged and thank to this the labor productivity grew up of 12.5%.

4.5 Results and Future Plans

The results of FI pillar are growing every year, we started with a year saving of 17.000 € in the first year and we arrived at a saving of 122.925 € in 2019 thank to the FI pillar activities.

Since the beginning of TPM activities FI pillar contributed increasing the productivity, the OEE and the decreasing of the Rework and Scraps. The project launched brought excellent result in those areas and helped the company reach the KMI's of the plant.
In the future the FI pillar will be focused on the expansion of the application of the MES software to know deeper where losses are located. This to launch every time the right initiatives to increase the OEE of the lines. The FI pillar will also have to improve the reduction of material waste, the reduction of Labor Losses on SVA and NVA activities, to go deeper in labor Deployment on Organizational Losses and enhance the problem-solving skills of the operators.

Furthermore, to better choose the machine and the projects to be launch we know that we need to have a better quantification (€ that the company loose due to the bad performances) of the losses, to do that we are creating a system that evaluate the Overall performance of each machine giving us the possibility to understand which are the machine that are costing more to the company and which are the root causes.
CHAPTER 5
Autonomous Maintenance
5 Autonomous Maintenance Activities

5.1 Outline – Aims, Goals and Concepts

The mission of Autonomous Maintenance Pillar is “Involving operators in the equipment management through the creation, implementation and improvement of cleaning, inspection and lubrication standards and doing small adjustments”.

“The Operator is the Host of his workplace. Nobody knows it better than him/her”

In order to pursue this aim, the goals of AM are:

- Every operator takes care of his/her machine to prevent equipment deterioration through correct operation and daily checks
- Bring equipment to its ideal state through restoration and proper management
- Establish the basic conditions needed to keep equipment well-maintained

Another important goal is to use the equipment as a means of teaching people new ways of thinking and working.

The AM Pillar vision was inspired by the Operations vision: it is clearly stated that we firmly want all operators to participate in the maintenance of machines, assume ownership of equipment, take responsibility for preventing deterioration and must abandon the old mindset of “I make – You (Maintenance technicians) fix”.

Figure 47: AM Mindset

AM Pillar started in January 2014 and followed the route below as shown in Table 7:
During the First phase of the Pillar, we decided our goals and understood the needs to start the Pillar. The main target was to improve the knowledge of Production Operators, enabling them to take care of their machines and motivating them to achieve and maintain best practices.

The Pillar started the Pilot project on the wrapping machines, which were considered as a whole “wrapping line”. The line was chosen because these machines were not much complicated to manage but among operators, there was a lack of knowledge both about the machine and how to perform operative procedures. In other words: they were not “Autonomous”. Impacts of Pillar on the machines was observed and tendency to adopt the change in attitude of our operators was noticed easily. This was done in order to proceed / expand the implementation of AM on the critical and complicated lines (after learning about equipment condition and resource requirements through pilot activities). After the standard implementation of steps 1-2-3, which we closely followed (underlined in the next chapters), we wanted to focus on the process of transferring Maintenance activities to Production. We initially analysed and deployed them into activities and subsequently collected them into different SOPs (Standard Operative Procedures).

**Table 7: AM pillar Masterplan**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AM Targets, organisation &amp; Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Standards &amp; Roll out of AM Team</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1, 2, 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Standards and Roll out of Step 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Standards and Roll out of Step 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Standards and Roll out of Step 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Standards and Roll out of Step 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 48: Production Volumes on Moulding Lines**

[Graph showing production volumes on moulding lines with data for years 2014 to 2021]
After the AM practice on the wrapping line (which is composed of 26 single machines), operators were able to manage the activities of cleaning, inspection and lubrication. The combined efforts of Production and Maintenance gave very positive results. After seeing the effectiveness of steps 1-2-3, in the fourth quarter of 2016 the Pillar started the projects on our crucial and critical Moulding lines: Winkler and Gianduiotto. In 2015, 46% of moulded production volume were produced on Winkler as shown in Figure 48.

Since the beginning the inter-functional team was made under the Supervision of VP (Vice-President) of Operations and leadership of Production manager.

As we can see in Figure 49, the Production Manager leads the Pillar with the support of Maintenance, Quality and TPM specialist to coordinate all the project and give methodological support. The Pillar’s members meet twice per month.

Without any doubt, we can say that the implementation of AM changed the attitude of everyone. There was certainly an improvement in operational skills and competences, but the biggest achievement was the change of working culture.

A great boost to AM was definitively given when the other Pillars have been launched.

The link with other Pillars is significant; particularly for Safety, Focused Improvement, Planned Maintenance and Training & Education Pillars; for example, the Table 8 below shows step-by-step the support that these Pillars are giving to AM.
### Table 8: AM Collaborations with other pillars

| AM ↔ T&E | The most important collaboration between T&E and AM is in the Step 4; during this step AM and T&E worked together to equip the Training room, develop the training material and schedule the training sessions for the employees. |
| AM ↔ SA | AM and SA work to assure the elimination of risks while performing an activity by raising the awareness about the importance of safety at work. They evaluate the working standards to assure a safe workplace. |
| AM ↔ PQ | PQ and AM work together to assure the premium quality of our products and the hygiene of all machines by standardizing the procedures and spreading the "first time right" culture among employees. |
| AM ↔ PM | These two pillars work side by side. The relationship between with AM and PM is substantial. The technicians train the operators to improve their skills concerning breakdown prevention and basic maintenance activities. Nevertheless, in step 1 the collaboration of PM is essential in order to solve all the tags relating to basic restoration. Prioritization is done based on the ABC classification performed by PM. |
| AM ↔ FI | FI gives strong support to the AM pillar by providing the right deployment of lines. Moreover, these two pillars work together to increase the OEE (AM helps to increase OEE by eliminating sources of dirt which reduce the cleaning time). |

AM pillar activities impact on OEE losses and technical efficiency by reducing cleaning time, machine stoppages relating to basic conditions and intervention time reduction (improving the operator skills).

Furthermore, we do believe that 5S guarantee orderly areas and this contributes to prevent accidents. It was started in 2013 and it has been implemented all over the plant and now it has become the part of our daily life.

KAIs (Key Activities Indicator) concerning 5S and Cleaning audits, number of tags issued, and people involved in AM are monitored in every (bi-monthly) pillar meeting.

We have set several KAIs (key activity indicators) in order to monitor all internal main activities, essential for KPIs improvements.
### Autonomous Maintenance KPIs / KAIs

<table>
<thead>
<tr>
<th>DRIVER/KPI</th>
<th>Description</th>
<th>Measure unit</th>
<th>Expected trend</th>
<th>Historical data</th>
<th>2020 YTD (Sep)</th>
<th>Target 2020</th>
<th>Vision 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>P KPI</td>
<td>Short stops</td>
<td>#/month</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>2918.7</td>
<td>2813.2</td>
<td>3357.9</td>
<td>4178.3</td>
</tr>
<tr>
<td>P KPI</td>
<td>Runtime</td>
<td>#/1000 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>1092.8</td>
<td>993.7</td>
<td>1116.7</td>
<td>1281.3</td>
</tr>
<tr>
<td>P KPI</td>
<td>Audit 5S</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>85%</td>
<td>87%</td>
<td>92%</td>
<td>96%</td>
</tr>
<tr>
<td>P KAI</td>
<td>Audit 5S</td>
<td>N/year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>45</td>
<td>53</td>
<td>168</td>
<td>180</td>
</tr>
<tr>
<td>M KAI</td>
<td>Operators involved in the AM</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>34%</td>
<td>39%</td>
<td>44%</td>
<td>52%</td>
</tr>
<tr>
<td>M KAI</td>
<td>TAG issued</td>
<td>N./Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>164</td>
<td>322</td>
<td>416</td>
<td>615</td>
<td>606</td>
</tr>
<tr>
<td>M KAI</td>
<td>TAG closed</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>87%</td>
<td>84%</td>
<td>84%</td>
<td>73%</td>
<td>68%</td>
</tr>
</tbody>
</table>

### Table 9: Explosion of Cleaning time per line

<table>
<thead>
<tr>
<th>DRIVER/KPI</th>
<th>Description</th>
<th>Measure unit</th>
<th>Expected trend</th>
<th>Historical data</th>
<th>2020 YTD (Sep)</th>
<th>Target 2020</th>
<th>Vision 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>P KPI</td>
<td>AVVILUPPAGGIO</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>13.8%</td>
<td>13.7%</td>
<td>13.3%</td>
<td>12.9%</td>
</tr>
<tr>
<td>P KPI</td>
<td>GIANDIUOTTI</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>19.0%</td>
<td>24.0%</td>
<td>22.7%</td>
<td>21.8%</td>
</tr>
<tr>
<td>P KPI</td>
<td>BINDLER</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>15.2%</td>
<td>14.5%</td>
</tr>
<tr>
<td>P KPI</td>
<td>DELVER</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>21.3%</td>
<td>16.3%</td>
<td>14.3%</td>
<td>11.0%</td>
</tr>
<tr>
<td>P KPI</td>
<td>FAG</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>17.3%</td>
<td>15.8%</td>
<td>14.3%</td>
<td>15.0%</td>
</tr>
<tr>
<td>P KPI</td>
<td>ITECH</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>1.6%</td>
<td>3.3%</td>
<td>4.6%</td>
<td>3.4%</td>
</tr>
<tr>
<td>P KPI</td>
<td>PMR</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>9.0%</td>
<td>8.8%</td>
<td>4.6%</td>
<td>4.6%</td>
</tr>
<tr>
<td>P KPI</td>
<td>JOINTECH</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>11.5%</td>
<td>11.0%</td>
<td>10.2%</td>
<td>11.0%</td>
</tr>
<tr>
<td>P KPI</td>
<td>SIMIONATO</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.2%</td>
<td>0.0%</td>
</tr>
<tr>
<td>P KPI</td>
<td>WINKLER</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>14.7%</td>
<td>13.4%</td>
<td>13.3%</td>
<td>13.2%</td>
</tr>
<tr>
<td>P KPI</td>
<td>TOSTINO</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>3.2%</td>
<td>3.5%</td>
<td>2.8%</td>
<td>2.5%</td>
</tr>
<tr>
<td>P KPI</td>
<td>LINEA CREME 617</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>4.6%</td>
<td>4.0%</td>
<td>3.4%</td>
<td>3.7%</td>
</tr>
<tr>
<td>P KPI</td>
<td>LINEA CIOCCOLATO 618</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>4.2%</td>
<td>4.5%</td>
<td>4.0%</td>
<td>3.8%</td>
</tr>
<tr>
<td>P KPI</td>
<td>GELATINE</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>10.2%</td>
<td>9.5%</td>
<td>8.3%</td>
<td>10.4%</td>
</tr>
</tbody>
</table>
Table 10: Technical Efficiency per line

**Technical Efficiency**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>KPI</td>
<td>AVVILUPPAGGIO</td>
<td>%</td>
<td>N/A</td>
<td>85.2%</td>
<td>86.9%</td>
<td>86.2%</td>
<td>86.2%</td>
<td>88.7%</td>
<td>90.2%</td>
<td>90.0%</td>
<td>92.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>GIANDUIOTTI</td>
<td>%</td>
<td>N/A</td>
<td>83.2%</td>
<td>81.0%</td>
<td>80.6%</td>
<td>75.1%</td>
<td>75.5%</td>
<td>80.2%</td>
<td>80.0%</td>
<td>80.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>BINDLER</td>
<td>%</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>68.4%</td>
<td>67.2%</td>
<td>70.6%</td>
<td>75.0%</td>
<td>85.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>DELVER</td>
<td>%</td>
<td>N/A</td>
<td>85.0%</td>
<td>92.0%</td>
<td>81.8%</td>
<td>86.0%</td>
<td>87.4%</td>
<td>89.6%</td>
<td>88.0%</td>
<td>92.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>FAG</td>
<td>%</td>
<td>N/A</td>
<td>92.7%</td>
<td>93.1%</td>
<td>94.2%</td>
<td>91.2%</td>
<td>92.0%</td>
<td>91.2%</td>
<td>92.0%</td>
<td>92.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>TIECH</td>
<td>%</td>
<td>N/A</td>
<td>86.3%</td>
<td>70.6%</td>
<td>80.6%</td>
<td>80.2%</td>
<td>80.0%</td>
<td>92.9%</td>
<td>81.0%</td>
<td>82.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>PMR</td>
<td>%</td>
<td>N/A</td>
<td>64.6%</td>
<td>72.7%</td>
<td>78.0%</td>
<td>85.3%</td>
<td>83.9%</td>
<td>92.5%</td>
<td>75.0%</td>
<td>85.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>JOINTECH</td>
<td>%</td>
<td>N/A</td>
<td>83.7%</td>
<td>83.7%</td>
<td>83.6%</td>
<td>84.9%</td>
<td>85.8%</td>
<td>93.6%</td>
<td>85.0%</td>
<td>85.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>SIMONATO</td>
<td>%</td>
<td>N/A</td>
<td>86.5%</td>
<td>87.2%</td>
<td>84.6%</td>
<td>77.6%</td>
<td>76.8%</td>
<td>73.8%</td>
<td>80.0%</td>
<td>80.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>WINKLER</td>
<td>%</td>
<td>N/A</td>
<td>85.5%</td>
<td>86.8%</td>
<td>88.8%</td>
<td>87.5%</td>
<td>87.2%</td>
<td>87.6%</td>
<td>87.5%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>TOSTINO</td>
<td>%</td>
<td>N/A</td>
<td>90.1%</td>
<td>90.5%</td>
<td>90.2%</td>
<td>91.3%</td>
<td>94.6%</td>
<td>94.7%</td>
<td>95.0%</td>
<td>96.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>LINEA CREME 617</td>
<td>%</td>
<td>N/A</td>
<td>84.6%</td>
<td>88.3%</td>
<td>90.2%</td>
<td>94.6%</td>
<td>97.3%</td>
<td>99.8%</td>
<td>97.0%</td>
<td>97.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>LINEA CIOCCOLATO 618</td>
<td>%</td>
<td>N/A</td>
<td>91.7%</td>
<td>91.4%</td>
<td>91.3%</td>
<td>92.1%</td>
<td>92.1%</td>
<td>92.3%</td>
<td>92.1%</td>
<td>94.0%</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>GELATINE</td>
<td>%</td>
<td>N/A</td>
<td>91.2%</td>
<td>91.4%</td>
<td>91.4%</td>
<td>91.9%</td>
<td>94.3%</td>
<td>95.6%</td>
<td>96.0%</td>
<td>96.0%</td>
<td></td>
</tr>
</tbody>
</table>

**Green** → Better than 2019  
**Red** → Worse than 2019

5.2 Key Points of Activity

*Figure 50: AM Timeline*
The table 4 shows the Master plan for AM on all the A-B-C Class machines. As shown in Figure 50, the 5S methodology had been started before the AM pilot projects in order to start changing the way of people’s thinking and focus on the elimination of waste throughout the enterprise, create cost savings while establishing an environment of continuous improvement.

Table 11: AM steps expansion on the lines

![Table 11: AM steps expansion on the lines](image)

Figure 51: Expansion of the steps of AM

![Figure 51: Expansion of the steps of AM](image)

Our current status of the expansion/implementation of the steps of AM is represented in this Layout as shown in Figure 51:

Currently, 78% of lines have finished Step 4. The Table 12 shows the summary of lines covered by following AM steps.
### Table 12: No. of lines covered by AM steps

<table>
<thead>
<tr>
<th>AM STEPS</th>
<th>COMPLETED [No.]</th>
<th>CLOSED [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP 4</td>
<td>11</td>
<td>78%</td>
</tr>
<tr>
<td>STEP 3</td>
<td>13</td>
<td>93%</td>
</tr>
<tr>
<td>STEP 2</td>
<td>13</td>
<td>93%</td>
</tr>
<tr>
<td>STEP 1</td>
<td>14</td>
<td>100%</td>
</tr>
</tbody>
</table>

### 5.3 Step-by-Step Implementation and Diagnosis Systems

#### 5.3.1 Step 0 – 5S implementations

5S system in Caffarel is the foundation of the LPW and AM Pillar. It is considered the main tool that helped change the mentality of people and their way of reacting.

A cross-functional team consisting of personnel from various functions like production, maintenance, safety and industrial performance was formed. The task for this team was to lastingly implement a basic understanding for cleanliness and order, as well as to continuously improve it. So, stepwise masterplan was created for implementation of 5S for all the production departments. In Table 13 you can see the 5S-master plan for Mass-preparation department.

To maintain the System, specific trainings related to 5S are given to involved employees, and audits are carried out regularly to continuously improve the standards and to develop them further. Currently, 5S Methodology is present in whole plant, also including the maintenance office.

![Figure 52: 5S System](image-url)
Table 13: Example of 5S- Master Plan for the Mass-preparation department

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Owners</th>
<th>Recognizable</th>
<th>Planned</th>
<th>Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SEIRI - Saperare</td>
<td></td>
<td></td>
<td>table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SEITON - Semplicificare la gianciale</td>
<td></td>
<td></td>
<td>table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. SEISO - Scoprire i problemi attraverso la politica</td>
<td></td>
<td></td>
<td>table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. SEIKETSU - Standardizzano</td>
<td></td>
<td></td>
<td>table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. SHITSUKE - Sostenere il miglioramento continuo</td>
<td></td>
<td></td>
<td>table</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

First step was sort (SEIRI) and the objective was to remove the unnecessary objects and keep only what is really needed. At each line, three types “ZAD: Zona di Attesa delle decisioni” (Pending Storage Areas) were created where all the (useful; unused; to be repaired) materials, instruments, tools, etc. were stocked with the help of tags (as shown in Figure 53).

Second step was the Set-in order (SEITON) phase; once all the things were sorted; useful things were placed in a systematic way in order to make them easily accessible when needed. We created certain OPLs (One Point Lessons) in order to start developing the new standards.
The third “S”, shine (SEISO), was developed to keep everything clean and tidy. A plan for reducing/eliminating dirt was established; the activities were prioritized, and the results were registered in OPLs in order to have traceability of the improvements.

The next “S” Standardize (SEIKETSU) consist of building a strong set of procedures to maintain the first 3S. So, cleaning and positioning standards were developed (SOPs) as shown in Figure 56.
Some of the standards also refer to an OPL number like in below as shown in Figure 57, the OPL was created for accessing the acceptability state of floor lines at shop floor.

Here below in Figure 58, it is shown an example of the random work station indicating the situation before and after 5S.
In order to maintain these standards, the final “S” was developed which is called “Sustain” (SHITSUKE). It is the crucial “S” and in order to sustain the positive results, 5S “Standard Management System” was developed. Our 5S system provides an audit plan that involves 21 members from different functions, audit the situation of an assigned line or area by filling a check list on weekly basis for each department.

Every department has its own 5S-Board, where all the activities related to 5S are managed by the assigned 5S-coordinators of the departments for example the 5S Board of moulding department as shown in Figure 59.

5.3.2 Step 1 – Initial Cleaning

The target of AM Step 1 is to perform the initial cleaning and restore the basic condition of the machines.

The Initial Cleaning steps are mainly: definition of the team members and leader by involving different functions along the operators of the selected areas (Production, Maintenance, Industrial performance, Safety, and Quality). Planning of the total clean out event (at least 8 hours for complete cleaning). Once it is all prepared and planned, cleaning and tagging is started in order to restore the machine to its basic condition. At the end, temporary standards and
Schedules are prepared for sustaining the basic condition of the machines. Step 1 of AM is closed by an audit performed by the pillar. At least 75% of the tags must be closed in order to pass the audit. Step 1 (Initial cleaning and tagging process) is divided into following partial steps.

5.3.3 Step 2 – Eliminate sources of dirt and hard to clean and inspect areas

The target of AM Step 2 is to identify sources of dirt and by doing root case analysis eliminate them. During the previous step, by doing initial cleaning the team highlighted the sources of dirt and hard-to-clean areas. The list of sources of dirt and hard-to-clean/inspect areas are made...
and analysed by using the 5whys analysis. By involving FI and PM pillars, action plan is created to resolve the root of the problems. After the implementation of new technical modifications, cleaning standards are updated. Step 2 of AM is closed by an audit done by the pillar. The target of step 2 is to eliminate 75% of the registered sources of dirt.

Step 2 (Elimination of SOD and HTC areas) is divided into following partial steps.

2.1 Identification of SODs and HTC areas

2.2 Creating list of SODs and HTC areas

2.3 5 Whys Analysis

2.4 Eliminating SOD’s and HTC areas

2.5 Monitoring Results

Figure 61: Step2 activities
5.3.4 Step 3 – Create and maintain cleaning, inspection and lubrication standards

The target of AM Step 3 is to implement standards for cleaning, inspection and line lubrication and consequently to increase the performance.

At the beginning of this step, the AM team standardizes all the cleaning times which are measured previously in step 2. The inspection and lubrication points are listed with the help of maintenance department and based on the experience of operators. After that general inspection and lubrication standards are defined. The identification tags (which is based on colour scheme: Blue for cleaning; Green for inspection; Red for lubrication) with numbers are attached on the machine in order to reach all these points efficiently during performing CILT activities. Moreover, layout CILT of the machine is created to identify (inspection, lubrication and cleaning) points. For achieving the best practice of cleaning, inspection and lubrication activities, SOPs are created with the help of t-cards. These t-cards are managed by T-Board as shown in Figure 63. At the end of this step, Standard management system is created with the help of check lists, which contains all tasks to be done during working hours.

Step 3 (Creating and maintaining CILT) is divided into following partial steps

Figure 62: Step 3 activities

- **3.1** Creating Inspection, lubrication and cleaning standards
- **3.2** Mapping inspection, lubrication points
- **3.3** Creating SOPs for cleaning, inspection & lubrication
- **3.4** Creating standard management system CILT check list
3.5 Monitoring Results

**T-BOARD:**

T-boards are used to manage the AM activities of the relevant line through t-cards. Along the t-cards on the board, we can also find the CILT standards, the layout of the line with indication of inspection and lubrication points, signature sheets. T-cards are used to manage the activities, that has to be done on the defined frequency/interval. Based on the running week, the operator takes the corresponding t-cards, performs the activity, signs on the register sheet and returns the t-card based on the defined frequency to the relevant week.

*Figure 63: Example of T-Board for Delver line*
5.3.5 Step 4 – General Inspections

The target of AM step 4 is to increase the competences/know-how of employees about machines and to improve the ability to inspect critical points of the machines.

After passing the audit step 3, in order to determine what and how ought to inspect, components involved in the main losses of the plant are analysed. From the analysis we identified 4 main subjects: mechanics, transmission, electrical part and pneumatic.

Therefore, theoretical material and interactive boards were developed through the involvement of maintenance and T&E Pillar. Inside the training material, general inspection manuals are created in order to describe the basic functions and structure of the equipment to be inspected, its components with their names and functions, pass-fail criteria, inspection procedures and actions to take when abnormalities are discovered. The theoretical manuals were not enough to enable operators to understand this information fully. So, we developed the training room equipped with all basic functional elements (nuts, bolts, lubrication systems, drive systems, pneumatics, electrical systems and coupling systems) to help operators understand fully by doing experiments with them. At the end of the training, the level of learning was tested through a theoretical exam. In case an operator fails the exam, he must repeat the lesson and the exam.

Subsequently the training continued with the application of the concepts directly on the lines involving all the machine operators in order to highlight problems and add or modify the current inspection points. During the session the important inspection and lubrication points were reviewed by discussing any improvements. A list of new inspection and lubrication points was made and integrated with t-card system. In order to improve visual management some machine parts were modified and indicated acceptable ranges on the instruments to facilitate correct operations.

Step 4 (General inspection) is divided into following partial steps
**Figure 64: Step4 activities**

4.1 Classifying the training topics and Creation of training material

4.2 Developing the training room

4.3 Planning & Execution of the training sessions in the training room

4.4 Training on the line

4.5 List of improvements
5.3.6 Diagnosis System

In Caffarel, there are several diagnosis systems based on standards of 5S and AM. The target of these diagnosis systems is to detect deviations and to eliminate them. In the plan we monitor and diagnose the lines by using these audits:

- Certification Audit from each AM step (self-audit)
- Certification Audit from each AM step (Pillar audit)
- AM-PQ Audit
- 5S Audit

Certification Audit from each AM step (Self-Audit and Pillar-Audit):

Developing an autonomous maintenance program in steps, as described above, has two advantages that make the program especially effective:

- Activities produce concrete results as they proceed
- Results are confirmed as part of the program

The single most important factor in the success of an autonomous maintenance program is conducting a careful audit during and on completion of each step by team leader and the AM pillar to confirm the results achieved and point the direction for further work as shown in Figure 65. It is only passed if the team gets a score equal or higher than 90 points.
5S Audit:

The 5S-Audit management system is shown in Figure 66.

An audit plan is made that involves members from all levels of the organization including Front line managers and Vice president of operations. According to plan, they monitor the situation of a specific line or area by filling a check list on weekly basis for each department.

A check list which evaluates each “S” in details and talk about the situation of

- Material, tools and equipment in use
- Materials and tools in their assigned position
- Line, area and tools cleaning
- Standardization
- Sustainability / People’s involvement / Action plan

Each voice has a weight and the score for each voice is from 0 to 2. “0” is given to the voice, when there are more than 2 anomalies have been found. The Standard 5S-Audit checklist is shown in Figure 67. At the end of the audit the score and anomalies found, is then communicated by putting data in the system, and then 5s-coordinators of the departments manage action plan (as shown in fig) aiming to resolve these abnormalities in a defined time. Action plan for resolving the abnormalities found by audit is shown in Figure 67.
**AM AUDIT CHECK LIST:**

In association with PQ pillar, AM audit check list was made which is used to verify the activities of cleaning, inspections and lubrication based on the standard CILT of the line.

The Audit is carried out by the shift in charge and head of department on daily basis. As for the cleaning of allergens, if the cleaning standard is not up to mark and respected, the auditor asks the operator to perform the cleaning activity and stops the production until the completion of the cleaning.
### Activity Status, status of each step, activity boards, one-point lessons, etc

#### 5.3.7 Status of each step

In Caffarel, our production lines on which we are implementing AM, were classified according to ABC criteria by PM pillar. We have **7 A-class, 4 B-class** and **3 C-class** lines.

The mission of AM pillar was to start the implementation of AM from A-class lines, which were more crucial and had high impacts on the production and to expand till C-class lines.

---

**Figure 68: AM-PQ Audit checklist**

<table>
<thead>
<tr>
<th>N°</th>
<th>Argomento</th>
<th>Punti da Verificare</th>
<th>Punteggio</th>
<th>Commenti</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conoscenze di base</td>
<td>L’operatore sa individuare lo standard corretto sulla T-Board?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Operatore</td>
<td>Verificare che le attività di pulizia siano state eseguite secondo quanto riportato nello standard CILT di riferimento</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Linea</td>
<td>L’area intorno alla linea si presenta pulita?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Linea</td>
<td>Le parti macchina necessarie alla lavorazione sono pulite ed in ordine?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>TAG</td>
<td>Durante le attività di pulizia sono state evidenziate fonti di sporco o aree difficili da pulire, non ancora note e segnalate?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**AREA: DATA:**

<table>
<thead>
<tr>
<th>AREA</th>
<th>NUMERO</th>
<th>DATA Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Soddisfacente 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alcune migliorie da apportare 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non soddisfacente 0</td>
</tr>
</tbody>
</table>

**Punteggio**

<table>
<thead>
<tr>
<th>Indicatori</th>
<th>Valore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soddisfacente</td>
<td>2</td>
</tr>
<tr>
<td>Alcune migliorie da apportare</td>
<td>1</td>
</tr>
<tr>
<td>Non soddisfacente</td>
<td>0</td>
</tr>
</tbody>
</table>

---

**Audit Validazione CILT AM-PQ**

<table>
<thead>
<tr>
<th>N°</th>
<th>Argomento</th>
<th>Punti da Verificare</th>
<th>Punteggio</th>
<th>Commenti</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Conoscenze di base</td>
<td>L’operatore sa individuare lo standard corretto sulla T-Board?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Operatore</td>
<td>L’operatore è a conoscenza delle attività da svolgere riportate nel CILT di riferimento?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Esecuzione</td>
<td>Controllare che le attività firmate come svolte, siano state eseguite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>TAG</td>
<td>Durante le attività di ispezione sono state evidenziate nuovi punti critici?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Ispezione**

<table>
<thead>
<tr>
<th>N°</th>
<th>Argomento</th>
<th>Punti da Verificare</th>
<th>Punteggio</th>
<th>Modifiche</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Operatore</td>
<td>L’operatore è a conoscenza delle attività da svolgere riportate nel CILT di riferimento?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Esecuzione</td>
<td>Controllare che le attività firmate come svolte, siano state eseguite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Conoscenze di base</td>
<td>L’operatore sa individuare lo standard corretto sulla T-Board?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>TAG</td>
<td>Durante le attività di lubrificazione sono state evidenziate nuovi punti critici?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Lubrificazione**

<table>
<thead>
<tr>
<th>N°</th>
<th>Argomento</th>
<th>Punti da Verificare</th>
<th>Punteggio</th>
<th>Modifiche</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Risultato Audit %**

<table>
<thead>
<tr>
<th>Area</th>
<th>Punteggio</th>
<th>Modifiche</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ispezione</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Pulizia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubrificazione</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Currently, the status of the lines is following for each step
100% of all ABC-class have completed **Step 1**. The layout of lines covered by step 1 is shown in the *Figure 69*.

**Figure 69: Lines (layout) covered by step 1**

100% of all B-lines; C-lines and 100%* of A-lines have completed **Step 2** and **Step 3** *(except our new line “BINDLER” classified as A-line, which was installed in June 2019).*

The layout of step 2 and step 3 is shown in the *Figure 70*. 
Currently, all ABC lines show a completion degree for AM steps 1-3 of 100% (except our newly installed line “Bindler”). In 2019, the rollout of Step 4 started and 86% (6 out of 7) of A-class lines, 75% (3 out of 4) of B-class lines and 67% (2 out of 3) of C-lines have been covered by step 4 as shown in Figure 71.
5.3.8 Team Board

The Team Boards are used as a tool for the visualization, control the AM activities. It is used on shop floor to highlight the team route, activities followed and their consequent results after each step. At the beginning of each step pillar determines what kind of information, related to this step must be present on boards. Here below an example of AM team board of the Winkler line is shown in the Figure 72.

![Image of AM team board]

5.3.9 One-point lessons

One-point lessons are a basic but powerful operational training tool on a single point used to educate/ teach the people about sharpen job-related knowledge and skills by communicating information about specific problems and improvements. One Point Lessons are short visual presentations on a single point that have three purposes:

1. **Basic knowledge:** This type of lesson fills a knowledge gap. It ensures the team members have the knowledge they need to do their job or participate in improvement activities. This adjacent OPL indicates which kind of appropriate plate has to use in order to adjust the height of the carpet gate.
2. **Problem:** This type of lesson gives actual examples of breakdowns, defects and other abnormalities to illustrate how to identify and/or avoid a workplace problem. It is most effective when presented immediately after the problem occurs. This OPL as shown in fig indicates “to control the position of cleats that should be straight, after a line stoppage due to mould interlocking”.

3. **Improvement:** This type of lesson summarizes the concepts, contents, and results of improvements that result from team activities. It helps teams in other areas make similar improvements. For example, this OPL represents the improvement in cleaning time by installing steel collection box.
We have OPL’s database as shown in Table 14, in order to register and manage all plant OPLs.

### Table 14: OPL Register

<table>
<thead>
<tr>
<th>Nr. OPL</th>
<th>Tipologia di Cura (Maintenance)</th>
<th>Area</th>
<th>Description</th>
<th>Type of OPL</th>
<th>Issued date</th>
<th>Compliance</th>
<th>Approved by</th>
</tr>
</thead>
<tbody>
<tr>
<td>001.01</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001.02</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001.03</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001.04</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001.05</td>
<td>1.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Problem:**

- **Description:** Issues with equipment malfunctioning.
- **Type of OPL:** Equipment malfunctioning.
- **Issued date:** 2010-03-15
- **Compliance:** In progress
- **Approved by:** A. Comigliati, D. Rich

**Improvement OPL**

- **Description:** Improved equipment design.
- **Type of OPL:** Equipment design improvement.
- **Issued date:** 2010-03-15
- **Compliance:** Completed
- **Approved by:** A. Comigliati, D. Rich
5.4 Autonomous Maintenance – Examples and Effects

Step 1 – Initial Cleaning

Following step 1 of the route of Autonomous maintenance methodology, we carried out the initial cleaning on the chosen line by making team consisting of relevant functions in the organization like: quality, maintenance, safety, production, industrial performance and the factory manager. During the event, there was the tagging activity to resolve all the anomalies found or to make improvements. Every anomaly was marked by tag. In Caffarel, tags are registered and managed by maintenance software called “CARL”. Areas that were difficult to clean and inspect were also identified as shown in Figure 78.

The Figure 76 below shows the initial cleaning activities of the team on our Winkler line.

Figure 76: Cleaning event along tagging

Figure 77: Deteriorated equipment

Figure 78: Sources of dirt
In *Figure 79* we can see some examples of restoring the machine's initial conditions thanks to step 1:

*Figure 79: Examples of restoring conditions*

![Figure 79: Examples of restoring conditions](image)

After the cleaning event, all the tags are registered in the Carl maintenance software. These are prioritized by the Maintenance Manager who assigns them to different technicians. Their progress is monitored in the weekly meetings by the steering committee.

*Figure 80: TAG System*

![Figure 80: TAG System](image)

While the tags are being solved by the person in charge, the team starts developing the first temporary cleaning standard. The initial AM activities on step 1 was completed with the creation of the first temporary cleaning standard after restoring the basic conditions of the line. One of the tangible outputs of Step 1 is the first provisional cleaning standard, where the activities are written down and later on analysed as shown in the *Figure 81.*
**Figure 81: First temporary cleaning standard**

<table>
<thead>
<tr>
<th>Area</th>
<th>Cleaning standard</th>
<th>Cleaning tools</th>
<th>Personal protective equipments</th>
<th>Who has to do it</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modelaggi Cioccolato</td>
<td>Fattoria guano</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Masticare</td>
<td>Fattoria guano</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Guida sono colture guano</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Coltura nero stampa</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Coltura nero stampa</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Deposito invecchiamento</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Deposito invecchiamento</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Macchinista</td>
<td>Piano macchinista</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Macchinista</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Uso frigorifero</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Aereocompressore e frigorifero</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Aereocompressore e frigorifero</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Aereocompressore e frigorifero</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Aereocompressore e frigorifero</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
<tr>
<td>Addetto arredo</td>
<td>Addetto arredo</td>
<td>Assenza accumulo di cioccolato</td>
<td>stracchi di buio di cioccolato</td>
<td>Addetto arredo</td>
<td>CFP 10 cambio termico</td>
</tr>
</tbody>
</table>

### Step 2 – Elimination of sources of dirt and hard-to-clean areas

After the successful completion of step 1, one of the first job activities of step 2 was analyzing the sources of dirt and areas that were difficult to clean and inspect, identified during step 1.

In order to eliminate them, we performed 5 whys analysis and found solutions in order to eliminate dirt and reduce cleaning time.

Here below, an example of a 5 whys analysis of accumulated chocolate waste under the licking roller and the possible solutions is shown in Figure 82.
The problem was that we used to find some chocolate waste under the licking roller. In order to clean that area, it was necessary to unscrew a transparent cover to reach the area. So, the time needed for cleaning the area was at least 30 minutes.

By using 5 whys, we identified several causes that led to the formation of dirt under the shaving roller and in order to resolve these causes, we found solution that was rising the edge of cochlea and adding an electrical resistance, allowing the cochlea to easily dispose the levelled chocolate in the bin. Consequently, this solution avoided the floor to get dirty and we reduced 15 mins of cleaning time and subsequently issued an OPL as shown in Figure 83.
All the sources of dirt and areas difficult to clean/inspect were listed after the detailed analysis with possible solutions as shown in Figure 84.

**Figure 84 : List of sources of dirt; difficult to clean and inspect areas**

<table>
<thead>
<tr>
<th>Cart. n.</th>
<th>Nature of the problem</th>
<th>The Area/place where does it produce</th>
<th>When does it produce</th>
<th>Counter measures</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDI_01833_18 SOD</td>
<td>Cream filler</td>
<td>The Filling machines of the creams is not aligned with the mold chambers. This causes the cream to leak out and drip the molds which carry dirt to the various areas of the machine.</td>
<td>Substituting and pulling the chain</td>
<td>Reducing of 15 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>RDI_01833_19 SOD</td>
<td>Shell guide outlet</td>
<td>Dirty moulds put back into circulation</td>
<td>Insertion of side scrapers so that they clean the moulds with a containing</td>
<td>Reducing of 20 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>RDI_01823_19 SOD</td>
<td>Demoulded Nazzas-Squares whe</td>
<td>Chocolate residue remain in the mold, they create non-compliance minor and dirt accumulates in the wheeled area and creates micro slabs</td>
<td>A blowing system to remove the crumbs inside the mold</td>
<td>Reducing of 8 mins of Cleaning, minor quality issues and reduction of short sizes</td>
<td></td>
</tr>
<tr>
<td>RDI_01823_19 SOD</td>
<td>Bottom Scrapper</td>
<td>Accumulation of scraps under the cokkies of the scraper roller</td>
<td>- Cokkies edge elevation</td>
<td>Reducing of 15 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>RDI_01804_19 SOD</td>
<td>Teno 3 mixer - Flavors dosage</td>
<td>The flavoring dispenser is not fixed so that spillage of flavor</td>
<td>Anchorage</td>
<td>Reducing of 10 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>RDI_01807_19 SOD</td>
<td>Teno 3 mixer - dough purg (mixture discharger)</td>
<td>Usage of the basin to drain the mixture, often causes a mixture</td>
<td>Connection to make discharging easier</td>
<td>Reducing of 10 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>HTC</td>
<td>Metal plate - Tunnel past bottom pouring shells</td>
<td>Cleaning: Area near the gears difficult to clean</td>
<td>Insertion of metal plate to avoid the fall of scrap</td>
<td>Reducing of 10 mins of Cleaning</td>
<td></td>
</tr>
<tr>
<td>HTC</td>
<td>Decoupling</td>
<td>Spillage of excess chocolate on chains, gears and wires that are difficult to clean</td>
<td>Inserting a metal plate to prevent the fall of scrap</td>
<td>Reducing of 10 mins of Cleaning</td>
<td></td>
</tr>
</tbody>
</table>

Here below there are some examples of elimination/restraint of sources of dirt and hard-to-clean areas.

There was accumulation of chocolate scraps on the cables coming from the scraper. This area is hard to clean due to the electrical cables. It was resolved by covering cables with metal plates.

**Chart 33: Improvement of the cleaning in the lines**
The flavoring dispenser was not fixed therefore spillage of flavor occurred. That was resolved by inserting anchorage to fix the position of flavoring dispenser.

**Chart 34: Improvement on the machines**

![Chart showing before and after improvement in the machines](image)

After resolving all the identified sources of dirt and areas that were difficult to clean, we revised the temporary cleaning standard (which was created at the end of step 1 as shown in **Figure 81**). The sum of all the interventions (which were mentioned in the **Figure 84**) carried out on the line led to approximately 40% reduction in cleaning times on the temporary cleaning standard (which was created during step 1). Now we just take 105 mins to clean the line after the book moulded product instead of 198 mins.

**Figure 85: Reduction in cleaning time after resolving Source of dirt**

<table>
<thead>
<tr>
<th>Zones</th>
<th>Reduction of Cleaning time (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tecno3 mixer</td>
<td>20</td>
</tr>
<tr>
<td>Cream filler</td>
<td>15</td>
</tr>
<tr>
<td>Licking roller</td>
<td>15</td>
</tr>
<tr>
<td>Shell fridge outlet</td>
<td>20</td>
</tr>
<tr>
<td>Demoulded Mazzotti-Square wheel</td>
<td>8</td>
</tr>
</tbody>
</table>

The objectives of the elimination of sources of dirt and hard to clean areas are to reduce the cleaning time, eliminate and contain the dirt and of course to update the previous cleaning standard by using the new times, SOPs (Standard Operative Procedure) and OPLs to standardize the activities.
**Step 3 – Create and maintain cleaning, inspection & lubrication standards**

After the successful completion of step 2, at the beginning of this step, the cleaning plan for periodic cleaning tasks was standardized, which were measured and revised during step 1 and step 2 respectively. The AM team collaborated with maintenance department and the PM Pillar to define areas that require lubrication that can be done by operators. Points for lubrication and inspection were defined and documented. Hence, standards for cleaning, inspection and lubrication were created named as CILT (cleaning, inspection, lubrication template) as shown in Figure 86.

*Figure 86: Standard CILT*

All inspection and lubrications points were marked on the lines with the help of colour code tags indicated with numbers.

An example of some inspection (like point 5 is used to control that the air pressure is around 6 bar, point 7 is used to control the Integrity of tape sponge and rubber rollers) lubrication points marked on the spread line is shown in Figure 87.
For achieving the best practice of cleaning, inspection and lubrication activities, SOPs were created with the help of t-cards by collaboration of AM team with maintenance department and the PM Pillar. T-cards were created for the activities, which are not being done on daily basis. On t-cards all details about the activity: how to be carried out, in which area, with which equipment, the time required and with what frequency are indicated.

In Figure 88, Figure 89 and Figure 90 you can see an example of t-card are used for inspection, lubrication, and cleaning respectively.
These t-cards are managed by T-Board as shown in Figure 63. T-board is divided in 52 small boxes (which represents weekly system), where we insert the t cards. We just use t-cards for the activities that have to be done on weekly, monthly, semestery and yearly basis. Based on the running week, the operator takes the corresponding t-cards, performs the activity by following the instructions given on t-card, signs on the register sheet and returns the t-card based on the defined frequency to the relevant week.

All t-cards are registered in the system in order to trace them as shown in the Table 15.
A per-shift and weekly base checklist was created to ensure that all assigned tasks in CILT are completed during working hours as shown in Figure 91.

**Figure 91: Standard management system for CILT**

Finally, a checklist was created to point out any abnormalities and deviation from the defined standards come across during cleaning, inspection and lubrication tasks.

**Step 4 – General Inspection**

At the beginning of step 4, with collaboration of PM pillar the critical components involved in the main losses of the plant were analysed by pareto diagram as shown in Figure 92. This was done to classify the topics, where there was lack of knowledge among operators and give them training to improve the know-how and ability to inspect the critical points of the lines. From the analysis, we identified 4 main subjects: mechanics, transmission, electrical part and
pneumatic. On these topics, theoretical training material were developed with collaboration of Planned Maintenance Pillar and Training & Education Pillar

Figure 92: Deployment of critical component

Inside the training material, general inspection manuals were created in order to describe the basic functions and structure of the equipment to be inspected, its components with their names and functions, pass-fail criteria, inspection procedures and actions to take when abnormalities are discovered. An example of training manual described with help of photos along description about transmission belts is shown in Figure 93 and Figure 94.

Figure 93: Basic Information about transmission
Based on the theoretical material, we created training room equipped with all basic functional elements (nuts, bolts, lubrication systems, transmission systems, pneumatics, electrical systems and coupling systems) to help operators understand fully by doing experiments with them.
After developing training material and training room, it has been started to give training to the operators in training room by technicians. The training is divided into two parts: theoretical session and practical session inside the training room. In theoretical session, the theoretical knowledge is given to them with the help of prepared training manual and in the practical session, operators are asked to perform some activities. The whole training process is shown in Figure 96.

Figure 96: Training of operators

After finishing the training sessions in the training room, the training continued with the application of the concepts directly on the lines by involving all the machine operators in order to highlight problems and add or modify the current inspection points as shown in Figure 96 indicated by point 4.

During the training on the line, inspection and lubrication points were reviewed and list of possible improvements was made as shown in Figure 97. This list mainly consists of new inspection points, which must be inspected by the operators. An example of new inspection points for Winkler line as shown in Figure 97, which were integrated with standard CILT developed during step 3.
After the training sessions, till now 50 new inspection points have come out (among them 35 points are related to electrical components) and several T-cards have been updated with the involvement of operators. One of the examples of revised t-card is shown in Figure 98, where the frequency and the time required to do the inspection has been modified.

Before step 4, there were just few electrical points to inspect for the operators. Thanks to the step 4, now operators can inspect the machine’s components more effectively and would be able to understand better the anomalies related to electrical components as well. Currently 54 operators have been trained inside the training room and on the lines with total 223 hours of training.
An example of list of improvements after the training sessions on Delver line

1. **Promotion of visual management:**

   In order to improve visual management, the layout with mapping of inspection and lubrication points was created and attached on T-board of the lines. Now by looking at the layout, operators can easily trace the exact position of the required points instead of searching on the machine. An example of the layout of CILT points of the Delver line is shown in the Figure 100.

   ![Figure 100: Mapping inspection and lubrication points on line layout](image)

   Some machine parts were modified, and acceptable parameter ranges were indicated on the instruments to facilitate the inspection activities, some examples of them are shown in Figure 101.

   One of the best example of visual management is the replacement of iron panels with transparent glass, that helps to inspect the machine for the presence of chocolate residues without dismantling the panel and reduced the downtime during cleaning.
The second example is the optimal range of the pressure, which is indicated by green line on the manometer to help the operator to understand easily any pressure anomaly by just looking into manometer.

Figure 101: Promotion of visual management

5.5 Results and Future Plans

Thanks to AM pillar, we are having positive impacts on O.E.E. and technical efficiency of the lines. This was achieved by the restoration and prevention of accelerated deterioration, by eliminating the sources of dirt and hard-to-clean areas and by standardizing the cleaning activities (Maintaining our policy of Hygiene Food safety 100%).

The graphs below show the typical results after the implementation of AM, trend to increase in the technical efficiency as shown in Chart 35 except our Delver line in 2018 having decrease in technical efficiency with respect to the previous years because of ( *new wrapping machine was installed at the end of the Delver line in 2018 and reduction of cleaning time as shown in Chart 36 on our main lines.
In addition to these projects, another role of the AM team is to increase overall employee involvement in AM activities. Each year, since the start in 2014, employee involvement has significantly increased. Now approx. 70% employee have been involved in AM projects, moving quickly towards the end goal of 100% (189 employees) involvement.
We have also positive trend towards 5S implementation in the plant as shown in *Chart 38.*

The implementation of AM has promoted a positive working culture with the employees in the plant. There were major improvements in operational skills and employee competencies, but the most significant achievement was the improvement of working culture.

Thanks to AM step 4, which gave us an effective platform in terms of Training Room to give basic training to the operators and give them the opportunity to learn more about the mechanical and electrical components by doing experiments, in order to improve their competencies with support of technicians.
**Future Plans:**

Our vision for the expansion of the AM pillar includes:

- The Expansion of the Step 4 in the entire plant within 2020
- Short stops and Loss reductions through collaboration with the T&E Pillar, PM & FI Pillars

Thanks to TPM, we created a standard definition of short stops with the collaboration of PM pillar and FI pillar and we started to analyse and measure the short stops by automated software “Stain (MES: Manufacturing Execution System)”, installed on the main lines (at the mid of 2018). Before the mid of 2018, the manual sheets were used on the lines in order to register the short stops and the data were not precise.

Now we have a precise platform and structured system in order to analyse the trend of short stops. In Chart 39, the data (of Years 20162017) mentioned in red means that it had been collected by manual (data collection) sheets; the black one is the sum of data collected by sheets and (after mid of 2018) by automated software and the green one is the data completely collected in 2019 by automated software.

![Chart 39: # short stops / 1000h run-time](chart)

After collecting precise information through software about short stops of 2019 on our mainlines, we will analyse the causes of these stops with help of AM methodology.

- The Extension of the AM methodology for all new future installations
- Further developing of training material for all main/new technologies with the T&E Pillar and PM Pillar

**Improve with**

- Standard Management & Audit system by installing dedicated software
- Culture of Visual Management in the entire Plan
CHAPTER 6

Planned Maintenance
6 Planned Maintenance Activities

6.1 Outline – Features and Issues of Equipment Maintenance

The Mission of the Planned Maintenance pillar is to “Eradicate breakdowns by developing a planned maintenance system”

Our vision is to reduce the number of failures and ensure the highest technical efficiency of production lines by:

- developing a 0 breakdowns culture
- empowering the failures mode analysis in order to eradicate the causes and chronic losses
- intensify preventive maintenance
- improving and perfecting our data collection
- improving the knowledge of maintenance technicians
- empowering the handover of information

The PM pillar had started in 2015 and follows a methodology summarized in the route shown in Figure 102 which is based on seven steps:

- In step 1: update and classify the machine list (A, B, C), set up data analysis and define the targets
- In step 2: restore basic conditions, support AM team and 5S, improve skills of maintenance technicians, launch loss reduction projects and introduce the breakdown analysis
- In step 3: analyse weak components, plan and improve the management of spare parts and organize PCS maintenance daily meeting
- In step 4: define and improve a planned maintenance system (TBM, CBM)
- In step 5: introduce predictive maintenance and update preventive maintenance plan
- In step 6: assess system costs and performance, support maintenance know-how evolution with T&E
- In step 7: ensure visibility of maintenance losses, continuous improvement of PM system
Figure 102: PM Pillar Route

In the figure below there are the pillar steps included in the Masterplan Table 16 to achieve the targets.

Table 16: PM Pillar Masterplan

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Examine the machines to understand the actual condition**
- **Restore the deterioration and improve the weak points**
- **Build up an information management system**
- **Build up a preventive maintenance system**
- **Build up an advanced preventive maintenance system**
- **Optimise the current Planned Maintenance System**

Ensure continuous improvement of Maintenance System to reach the Vision

Optimise the current planned Maintenance system

Build up advanced preventive Maintenance system

Build up preventive Maintenance system

Build up information Management system

Restore the deterioration and improve the weak points

Examine the machines to Understand the actual condition
The PM Pillar is composed by five members Figure 103 that meet twice a month; four members work in maintenance department and one in industrial engineering.

This is important to monitor constantly lines performance and maintain strong link with production.

To achieve our Mission, we have defined a set of indicators, KPIs & KAIs, and for each of them a target has been set as is shown below in Table 17. Our KPIs are focused on costs and technical availability, while for KAIs the focus is on preventive maintenance, the execution of breakdown analysis and intervention requests (through the tagging system) by production.

### Table 17: PM Pillar KPIs

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>KPI</td>
<td>Breakdowns #/1000 h</td>
<td>Runtime</td>
<td>9.4</td>
<td>6.5</td>
<td>5.2</td>
<td>2.8</td>
<td>2.2</td>
<td>2.1</td>
<td>2.0</td>
<td>GREEN → BETTER THAN 2018</td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>Breakdowns #/month</td>
<td>35.4</td>
<td>25.4</td>
<td>21.1</td>
<td>12.1</td>
<td>9.9</td>
<td>9.7</td>
<td>9.5</td>
<td>RED → WORSE THAN 2018</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KPI</td>
<td>MTTR h</td>
<td>1.5</td>
<td>1.4</td>
<td>1.4</td>
<td>1.6</td>
<td>1.3</td>
<td>1.5</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>KPI</td>
<td>Spare parts cost €/ton</td>
<td>41.1</td>
<td>40.0</td>
<td>42.0</td>
<td>28.0</td>
<td>27.0</td>
<td>25.0</td>
<td>21.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>Breakdowns eradicated</td>
<td>nd</td>
<td>nd</td>
<td>35.0</td>
<td>115.0</td>
<td>223.0</td>
<td>310.0</td>
<td>400.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>Intervention request closing time days</td>
<td>n.d.</td>
<td>74.5</td>
<td>32.9</td>
<td>24.7</td>
<td>24.6</td>
<td>20.0</td>
<td>15.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>Breakdown analysis vs total Breakdowns %</td>
<td>n.d.</td>
<td>11.8%</td>
<td>41.3%</td>
<td>77.9%</td>
<td>86.6%</td>
<td>95.0%</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>N‘ preventive work cycle released by CMMS #/year</td>
<td>214</td>
<td>253</td>
<td>282</td>
<td>450</td>
<td>460</td>
<td>490</td>
<td>650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>A class machines covered with Prev. Maint. %</td>
<td>nd</td>
<td>nd</td>
<td>57.0%</td>
<td>95.0%</td>
<td>96.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>KAI</td>
<td>Maintenance hours justified through CMMS %</td>
<td>75.3%</td>
<td>81.1%</td>
<td>81.2%</td>
<td>84.3%</td>
<td>88.4%</td>
<td>88.0%</td>
<td>80.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Our factory consists of 14 production lines (Figure 104), that we can further divide in 75 machines (Figure 105). The total equipments are about 760.

**Figure 104: ABC Lines classification**

![ABC Line classification chart]

The Mass Manufacturing department is based on three lines. The first line is dedicated to produce chocolate masses, the second one to prepare filling masses and Gianduiotto mass and the third line is dedicated to select and roast the hazelnuts. We manage and control this department through a software from the raw materials storage up to the tank farm where masses produced are stored. These three lines are very highly utilized and, for almost all the season, work three shifts a day.
The *Moulding Department* is based on 6 different lines which allow to produce many different items since we have a large range of SKU’s including seasonal product (e.g Easter eggs).

These 6 moulding lines are a mix of recent and new machines (e.g. Bindler Chocostar 620) as well as older ones; the technical complexity is mainly determined by the high number of items included in the lines.

The *Wrapping and Packaging Department* includes the rest of the lines and machines.

To optimise the maintenance resources in the most efficient way, the production lines had been prioritized. We put in place an ABC classification, that we update every six months to take in consideration eventual changes. The classification is based on seven parameters (*Figure 106*) as Safety, Quality, Work (utilization), Work Peak (utilization), Delivery, Frequency (of breakdowns), Maintainability. In addition, the expansion of preventive plans follows the ABC classification.

*Figure 106: Classification parameters*

<table>
<thead>
<tr>
<th>EFFECTS</th>
<th>STRONG (Forte)</th>
<th>AVERAGE (Medio)</th>
<th>INVALID (Nullo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFETY</td>
<td>If a fault occurs, the safety / environment can be compromised due to the fault itself or due to its repair</td>
<td>If a fault occurs, the safety / environment could be partially compromised</td>
<td>Invalid</td>
</tr>
<tr>
<td>QUALITY</td>
<td>If a breakdown occurs, defects may arise which compromise the food safety of the product</td>
<td>If a fault occurs, defects may arise which don't always ensure consistent quality standards</td>
<td>Invalid</td>
</tr>
<tr>
<td>WORK (saturation)</td>
<td>≥ 40%</td>
<td>40% &lt; &gt; 20%</td>
<td>≤ 20%</td>
</tr>
<tr>
<td>WORK PEAK</td>
<td>≥ 8 shifts per week</td>
<td>4 &lt; shifts per week &gt; 2</td>
<td>≤ 2 shifts per week</td>
</tr>
<tr>
<td>DELIVERY</td>
<td>Breakdowns cause interruptions or production losses</td>
<td>Rarely breakdowns cause interruptions or production losses</td>
<td>Breakdowns don't cause interruptions or production losses and the restoration of the machine is easy</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>≥10 breakdowns every 1000 run time hours</td>
<td>&lt; 10 breakdowns every 1000 run time hours &gt; 5</td>
<td>≤ 5 breakdowns every 1000 run time hours</td>
</tr>
<tr>
<td>MAINTENABILITY</td>
<td>MTTR ≥ 2,5 HOURS</td>
<td>&lt; 2,5 (HOURS MTTR) ≥ 1,5</td>
<td>MTTR &lt; 1,5 HOURS</td>
</tr>
</tbody>
</table>
If even only one of the first three parameters (safety, quality and work) is classified as “strong impact”, then the machine is classified as “A” (Figure 107).

**Figure 107 : ABC flowchart**

6.2 Maintenance Department Organization and Staffing

The Figure 108 shows the maintenance organization chart. Maintenance team is split in two groups: mechanics and electricians. The mechanics have a coordinator who reports to the maintenance manager; on the other hand, electricians directly report to the maintenance manager.

- Engineering & Maintenance (Maintenance manager): is the person in charge of the service unit both in terms of engineering and staff, he manages people who have precise tasks.
- Engineering: guides and coordinates the activities related to the development of technical projects related to construction, expansion of the plant and installation of machines either for optimization or for new products.
- Coordinates the progress of the relevant works by checking the availability of materials, construction works and assistance, tests and start-ups.
- Maintenance service plant engineering: guides and coordinates the installation and maintenance of thermal, hydraulic, compressed air generation, cold water generation and fire-fighting systems; manages and coordinates the projects related to the process piping and chocolate tanks.
• Maintenance specialist: is the PM pillar leader and is directly responsible for the management and analysis of KPIs, implementation of preventive maintenance activities, the management of Carl software (CMMS) and maintenance documentation in general.
• Maintenance service mechanical coordinator: guides, coordinates and controls the mechanical technicians, in order to guarantee the highest maintenance service for the production, quality and efficiency in general; he is responsible for the good management of preventive maintenance plans, spare parts and inventories.

Figure 108: Maintenance organization chart

6.3 Role Sharing between Operating Department and Maintenance Group

With the introduction of the TPM methodology it has been necessary to define and set the roles and the right balance of responsibilities between the maintenance and production departments. The purpose is to shape all the activities to increase line availability, reduce breakdowns and downtime through defined procedures. The Table 18 shows how the tasks are divided between AM and PM pillars.
Table 18: Role sharing between AM and PM

For example, every breakdown is analysed in cooperation between the maintenance technician and the head of line using a BDA (breakdown analysis) format shown in Figure 109.

Figure 109: BDA Format

Moreover, through the PCS meetings (production departments, maintenance, daily, weekly and monthly PCS meetings as shown in the Figure 110 below) we have an overview of all the problems and activities of the improvement teams, investment projects and measures coming from the pillars, departments or from engineering.
One very important step in the collaboration and share of roles with the AM Pillar is represented by the training courses held by members of professional maintenance who transfer electrical and mechanical basic skills to production workers.

Thanks to this, the production workers have a better understanding of what is happening on “their” machines; we are doing this in order to make the production workers more able to understand the behaviour and the weak signals of the machines. This helps them to describe the problem in the best technical way, that allows the maintenance technicians to have a more accurate idea of what happened and how to intervene.

### 6.4 Support for Autonomous Maintenance

The PM pillar supports AM pillar in several stages (*Table 19*). The technicians help the AM teams with their expert knowledge and delivers practical ideas and support in the improvements implementation; this process continues with a training focused on the basic mechanics and electricity concepts.
### Table 19: How PM support AM

<table>
<thead>
<tr>
<th>AM TEAM STEPS</th>
<th>STEP 1: Initial cleaning</th>
<th>STEP 2: Eliminate sources of dirt and hard-to-clean areas</th>
<th>STEP 3: Create and maintain CILT standard</th>
<th>STEP 4: General inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM SUPPORT</td>
<td>Active participation to the initial cleaning activity</td>
<td>Participation during the analysis of sources of dirt and hard-to-clean areas</td>
<td>Support to the creation of CILTstandard</td>
<td>Preparation and set-up of training room</td>
</tr>
<tr>
<td></td>
<td>Support in finding TAGs</td>
<td>Support in making restorations and modifications to eliminate the sources of problems</td>
<td>Training to the operators</td>
<td>Preparation of training materials</td>
</tr>
<tr>
<td></td>
<td>Support in removing TAGs</td>
<td></td>
<td></td>
<td>Delivery of the training</td>
</tr>
</tbody>
</table>

#### 6.4.1 Step 1 – Initial cleaning

In this step the maintenance technicians participate to the initial cleaning of the machine; our aim is to bring the machines to their initial conditions mainly through the emission of restoration and improvement TAGs (*Figure 112*). The maintenance technicians use their experience to find a solution for complex TAGs. In this phase most of the TAGs are solved.

*Figure 111: PM support in the initial cleaning activities*
6.4.2 Step 2 – Eliminate source of dirt and hard to clean & inspection area

In this step the maintenance technicians help to analyse (Figure 113) the source of dirt and difficult to clean areas list by trying to find possible solutions to eradicate or, at least, contain the problem.

Below it is possible to see an example (Figure 114) of a source of dirt containing. We have installed a side plate on the cochlea that removes the exceeding filling mass and a resistor on the drain pipe to facilitate draining and to prevent the build-up of filling mass.
6.4.3 Step 3 – Create and maintain cleaning, inspection & lubrication standards

In the third step the maintenance technicians contribute to the creation of cleaning, inspection and lubrication standards. The technicians, participating to the AM teams, train production workers on why, how, where and how often lubrication is necessary; the most important tasks are illustrated with the T-Cards (Figure 115, Figure 116 and Figure 117). In the T-Card tabs are illustrated the areas to be cleaned, the tools and PPE (Personal Protective Equipment) to be used, the frequency of the activities and their expected time.

Each type of T-Card has a defined colour-code: green for Inspection, red for Lubrication and blue for Cleaning. Every T-Card is placed on a map of the line as shown below in the Figure 118.
Figure 116: Lubrication T-Card

Figure 117: Cleaning T-Card

Figure 118: T-Card Map
6.4.4 Step 4 – General Inspection

With the step 4 the production workers are trained by expert maintenance technicians (Figure 119) about basic knowledge in the mechanics, electrics, pneumatics, hydraulics, transmission and lubrication areas.

*Figure 119: Training by expert technician*

For the training we use some panels (Figure 120) and information material (Figure 121) showing how many mechanical and electrical components work. The aim is to explain basic concepts to make the production workers able to inspect and act in the most proper way. There is also a practical session in which the operators are trained to use the tools to lubricate/grease the various components or, for example, to tight and adjust a chain.

*Figure 120: Electrical and Pneumatical panel*

*Figure 121: Training Material*
At the end of the training session there is always a test (Figure 122) to check if the operator has understood and learned the concepts.

Figure 122: Example of Mechanical test

In this training phase, we understood that, to be very effective, it is crucial to have a collaboration between the PM, AM and TE pillars.

6.5 Establishing Planned Maintenance System

The maintenance activities are always planned and checked with the production and planning departments; this happens at the beginning of the year, thanks to a long-term plan (in particular for preventive maintenance, Table 20), and during the year by means of dedicate meetings.

The priority is always based on the ABC classification, with a particular focus on safety, food safety and number of failures.

Table 20: Example of long-term plan
Our planned maintenance activities include different tasks managed through the CMMS (Computerized Management System Software), Carl Software, and Excel spreadsheets too:

- Preventive maintenance based on time-TBM and condition-CBM (the maintenance activities, their frequency and the expected time are various and very different for each machine; the frequency of activities can range from seven days to ten years and time expected from thirty minutes to eighty hours)
- Closing tags (request of intervention (“RDI”) including either the corrective maintenance related ones to restore the machine basic conditions or proactive maintenance ones to improve equipment functionality)
- Corrective maintenance performed during machine downtime is normally used to carry out extra end restoration activities

As explained before, we manage our planned maintenance through Carl Software. The preventive plans are relating to every specific production line or utility;

![Figure 123: Plan detail](image1)

The preventive maintenance plan is then divided in work cycles dedicated to every specific component, again with a specific frequency and expected time; every work cycle includes some specific tasks to explain in detail all the activities to be done.

![Figure 124: Work cycle with specific activities details](image2)
For some specific work cycles, whose completion is particularly complex, we associate maintenance standards that explain in detail, also through pictures and drawings, the activities to be performed (Figure 125).

**Figure 125: Maintenance standards**

Our goal is to fully cover all class A machines through a robust preventive maintenance plan; now the percentage is 96% (Figure 126).

**Figure 126: Percentage of preventive plan expansion on ABC machines classification**
6.6 Maintenance Information Control, Breakdown Analysis, MTBF, MTTR, etc.

To monitor the maintenance activities, we have several KPIs showing the trend and progresses on a weekly, monthly and yearly frequency. Twice a month, we organize a meeting to analyse the data, the issues and the progresses of the teams; in these meetings not just the members of the PM pillar participate, but all the entities that might be involved in the issues.

Once a month, the PM pillar members discuss the monthly KPIs in order to have an understanding of the problems and decide together where and how to intervene.

The most important indicator is the number of breakdowns; this is our breakdown and adjustment/short stop definition (Figure 127):

*Figure 127: Breakdown and adjustment/short stop definition*

Specifically, we extract the breakdowns and adjustments info out of our CMMS Carl and the short stops out of our MES STAIN +. The *Table 21* below shows in a simple way the differences.
We use different tools to eliminate the failures. The target is to eliminate all breakdowns to prevent reoccurrences.

Every breakdown is immediately analysed (through a defined and clear procedure, Figure 129) in collaboration with the production by means of the BDA (Breakdown Analysis) format (Figure 129)
At the beginning of 2020, we introduced new elements in the BDA format to deeply analyse the breakdowns timing; these elements are:

- 1 - Hour and minute when the breakdown occurs
- 2 - Hour and minute when the maintenance technician arrives
- 3 - Hour and minute when the disassembly/diagnostic ends
- 4 - Hour and minute when the repairing ends
- 5 - Hour and minute when the assembly ends
- 6 - Hour and minute when the machine restarts

All breakdown analysis sheets are stored into a database (Table 22) where we track the eradication (Table 23) and we can find all the information: the machine number, the date of breakdown, the breakdown description, the weak component, the root cause, the countermeasure, the 4M and all the repairing times mentioned above.
Table 22: BDA database

Table 23: Eradication tracking

Thanks to this we have more information, for example the 4M and the work type (Figure 131).
Performing a deployment, either through a Pareto or through the type of fault, we can understand where and when to focus our efforts.

In the Figure 132 below it is possible to see the average number of breakdowns per month divided by our class A and B lines.

We also analysed the weak components and we intervened on the most critical; in our database we have classified 114 different components.
6.7 Status of Corrective Maintenance

By Corrective Maintenance we mean all the activities of repair and/or component replacement occurring when the machine is not able to run, aimed to ensure the restoration of the functionality of the line/machine.

In Figure 134, it is possible to see that the number of corrective maintenance hours has many highs and lows during the year; this happens because we are a factory producing lots of seasonal products, for examples Easter eggs.

Various countermeasures have been introduced during the implementation of LPW to reduce the numbers and the hours of corrective maintenance:

- Expansion of preventive maintenance activities
- Analyses and eradication of breakdowns of the past (Breakdown Analysis, Major Kaizens, Standard Kaizens)
- Standards and procedures
- Improvements and modifications of machines and components (Weak component analysis)
6.8 Technical Developments for Automatic Maintenance

On some lines, we have installed automatic lubrication and greasing systems (Figure 135).

This is necessary because sometimes the point to lubricate is difficult to reach, in other cases the lubrication must be constant, in further other cases the line doesn’t work continuously because follows the seasonality of the products.

Figure 135: Two examples of automatic greasing system
6.9 Equipment Diagnosis Techniques, Status of Predictive Maintenance

We, basically, adopt two approaches on preventive maintenance: the time based-maintenance (TBM) and the condition-based maintenance (CBM).

6.9.1 TBM & CBM

Many machines, especially the most important ones and with more hours worked, are maintained based on time. At the beginning (2014) the time intervals between maintenance work cycles were based only on technician’s experience; now we have optimized the time intervals thanks to the data collection based on our six years experience. The intervals have also to be periodically updated following the run-time hours changing of the machines.

We use the TBM for all A and a part of B class machines and often including mandatory replacements of a component; the TBM is also used for components with linear time wear (such as rolling bearings) or electrical components where is not possible to identify signs of wear or deterioration. We use the CBM for a part of class B and for all C class machines and where the criticality of the components doesn’t affect the operation of the machine.

6.9.2 Predictive Maintenance

Since the beginning of the 2016 the company launched the predictive maintenance program, using third party companies with expertise in the field.

In order to select the right machines to monitor we have considered the following parameters:

- The importance that the lines have in factory (ABC classification) and if they represent bottlenecks
- Difficult to repair in a short time in case of breakdown
- Long lead times for having spare parts eventually not in stock

The lines of our mass department, the most important moulding lines and the mould washing machine have these characteristics. The Figure 136 below shows the distribution of vibration and lubrication point to analyse.
We monitor the conditions and check the situation around three times a year.
At the end of each inspection, the expert holds a meeting with us and explains all eventual anomalies. In the following days the expert performs the analysis of all data collected in the field and update us by telephone or email. All the results of the periodic analyses, carried out of the machines, are then added to excel database, where we can monitor the results of various detections and the trend.

The last acceptable value is represented by the Moderate range. If the machine turns to Insufficient or Serious levels, we proceed with a further inspection and, if the severe status has been confirmed, we proceed with the component repair or replacement. The Figure 140 shows the condition’s trend of a fan motor of our mould washing machine: since it reached the Insufficient level, the fan motor has been removed and rebalanced and in the following inspections the status had turned back to an acceptable Sufficient level.

Figure 140: Vibration Analysis trend
6.10 Lubrication control

The lubrication tasks are divided between machine operators (usually daily and weekly tasks) and maintenance technicians; both are in accordance with a precise lubrication plan.

Figure 141: Lubrication plan

The maintenance plans are included in the CMMS, while the production plans are managed through excel; this last had been created in AM steps 1-4 and in many cases the tasks have been transferred from maintenance to production. The lubrication tasks are shown in a list where the operators have to record the actions done. In order to make it easier the operators’ activities, we have attached a red dot with the number of each lubrication point directly on the machine; the lubrication plans also define the type of grease/oil and the required number of grease pump strokes.

Figure 142: AM Lubrication point

We use only food safety grade oils and greases; the lubricants are stored in a secure warehouse and all the containers are clearly marked.
6.11 Stock Control

In 2017, with the adoption of the 5S in the maintenance workshop, we have had many advantages:

- Separation of what is needed and unnecessary tools and materials
- Removal of unnecessary tools and materials
- All tools and materials are now in good conditions (Figure 144)
- Tools and materials are now classified by frequency of use (Figure 145)
- Critical areas are cleaned and inspected frequently
- Cleaning plans and auditing system in place
To improve the management of the tools shared by all the technicians, we introduced plates with the technicians’ names (Figure 146); every time a technician takes a tool, it leaves the name plate in its place. In this way, if another technician urgently needs the same tool, he knows exactly who is using it and consequently where to find it.
We had also installed a compactable warehouse to have a better order and separation of the spare parts. They are divided both by line / department and by type, and we have also installed specific drawers to further divide the components of common consumption such as screws, washers, ball bearings, etc. Thanks to this we have reduced the risk of unavailability and the time of spare parts search.

The management of spare parts is done through excel spreadsheets where we can find the article description, its positioning box, the number and the manufacturer code.
6.12 Control of Dies, Jigs, Measurement Instruments, Drawing, etc.

We run the following checks for equipment:

<table>
<thead>
<tr>
<th>EQUIPMENTS</th>
<th>INSPECTION INTERVAL</th>
<th>INSPECTION BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal detector</td>
<td>Once per shift</td>
<td>Production</td>
</tr>
<tr>
<td></td>
<td>Once per year</td>
<td>External lab</td>
</tr>
<tr>
<td>Check weigh scales</td>
<td>Once per year</td>
<td>External lab</td>
</tr>
<tr>
<td>Table top scales</td>
<td>Once per year</td>
<td>External lab</td>
</tr>
<tr>
<td>Thermometer</td>
<td>Once per year</td>
<td>External lab</td>
</tr>
<tr>
<td>Magnets</td>
<td>Once per month</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Temperature logger</td>
<td>Once per week</td>
<td>Maintenance</td>
</tr>
<tr>
<td>Sieves and filters</td>
<td>Once per month</td>
<td>Maintenance/Production</td>
</tr>
</tbody>
</table>

The results of the checks are recorded in several dedicated databases. If one of the checks has a negative result, we intervene immediately; for example, if one of the scales is not working properly, we recalibrate it with specific instruments.

In the maintenance department we also keep all the manuals relating (Figure 149) to the machines such as technical drawings, electrical diagrams, user manuals, their spare parts list and the equipment’s declarations of conformity. They are neatly catalogued first by department and more specifically by line and machine.
We also divided and catalogued in a dedicated closet all the machines’ declarations of conformity.

Figure 149: Manuals and Technical drawings

6.13 Maintenance Budgets and Control

6.13.1 How Maintenance Costs are determined

The plant is divided into cost centers, which are then divided into general ledger accounts. Budgeting of maintenance costs is managed through 5 general ledger accounts which include more than 80 individual cost centers. The maintenance cost centers are utilized for the overall maintenance management of the facility, utilities, supplies, repairs and maintenance, service agreements and salaries.

In 2019 around 2% of the revenues had been spent in the facility and the production lines maintenance.

Every year the maintenance budget is elaborated from previous years’ budget, forecast of expenditure, extraordinary maintenance activities and production volumes.

Maintenance goal is to link budget control with:

- Operational plan and targets
- Prevent budget overruns and identify anomalies in early stages
- Equipment efficiency
- Balance of:
- Contractors manpower and spare parts
- Machine obsolescence – extraordinary maintenance
- Preventive and corrective maintenance

The graph below shows last 5 years budget trend versus volumes produced. Maintenance budget remains stable in spite of the volumes increase.

*Chart 40: Maintenance costs per tons produced*

<table>
<thead>
<tr>
<th>Year</th>
<th>Maintenance costs / Tons (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>286.3</td>
</tr>
<tr>
<td>2016</td>
<td>271.9</td>
</tr>
<tr>
<td>2017</td>
<td>269.3</td>
</tr>
<tr>
<td>2018</td>
<td>218.9</td>
</tr>
<tr>
<td>2019</td>
<td>181.8</td>
</tr>
</tbody>
</table>

6.13.2 How Budget are classified

The budget of maintenance is divided into 5 general ledger accounts:

- Internal paid working hours
- Utilities maintenance (external services and spare parts)
- Equipment maintenance (external services and spare parts)
- Building maintenance (external services and materials)
- Maintenance of means of transport (external services and spare parts)

Internal hours are not included in the maintenance budget as they are part of personnel budget. Each expenditure is assigned to a specific cost center in order to create a complete cost data base.

6.13.3 Budget Item Breakdown

The largest share of the costs for maintenance with 60% are internal labour hours in maintenance. They are shown in red. In yellow are shown the costs for external contractors performing specific maintenance tasks on our lines. The spare parts expenses (blue) represent the smallest part of the costs.
6.13.4 Authority of Appropriation by Position Level

The Engineering and Maintenance Manager and the General Services Manager compile the annual budget. The Vice President of Operations and the Chief Financial Officer review and approve the proposed annual budget. Budget adherence is a KPI tracked by the maintenance department. The Engineering and Maintenance Manager has full responsibility of the budget compliance.

6.14 Planned Maintenance Examples and Effects

6.14.1 Case - Breakdowns reduction on MC0171 wrapping machine

This is a case of breakdown eradication which allowed us to definitively solve a problem. The line involved is the Delver, a moulding line for cut chocolate products that can be in-line wrapped; we installed the new wrapping machine in May 2018. The Figure 150 shows the wrapping machine where the problem occurred.
Step 1 – Problem identification

In the second half of 2018, we recorded 20 maintenance interventions (of which 9 were breakdowns) related to the product feeding in the wrapping machine.

Chart 42: Breakdown and adjustments on ACMA
**Step 2 - Target definition**

The goal was the breakdowns eradication and bring adjustments at lowest possible.

**Step 3 – Analysis**

We carried out a "5 why's" analysis with the help of photos of problems and drawings of the machine. Looking carefully at the machine, we understood that the problem was because of the loss of parallelism between the free toothed belt pulley and its mounting bracket.

This resulted in:

- sliding of the toothed belts towards the edge of the pulley
- overheating of moving parts and melting of the chocolate passing through
- sliding of the belts on the toothed belt pulley
- failure due to belt’s tooth breakage

The parallelism loss was caused by the wear on the mechanical support surface of the pulley pin.

*Figure 151: Problem identification*

*Figure 152: Draw of the problem*
Step 4 – Solving actions

The solution found had been the pulley pin redesign in order to increase its support surface. We initially drew a sketch of the new component and after we translated it into a real project. We replaced the original components with new ones at the end of December 2018.

Figure 153: Old component

Figure 154: Study for the new component
**Step 5 – Results**

Since January 2019 we haven’t had any breakdown due to this problem as shown in the graphs. The cost of the modification was approximately 300 €. This solution allowed us to save 79.2 labour hours in production and maintenance and 614 € of spare parts, quantifiable in a total benefit of 2831.9 € (Figure 158).

*Figure 156: Reduction of Breakdowns after the team*
Figure 157: Reduction of MTBF

Figure 158: Cost saving on MC0171

6.14.2 Case – Heating element

This is a cellophane wrapping machine used to wrap chocolates gift boxes.

Figure 159: Heating element to wrap chocolate gift boxes
Step 1 – Problem identification

Starting from the weak components’ analysis, in 2018 we decided to reduce the failures related with the heating element. After a deeper analysis, we identified the specific machine with the highest number of breakdowns.

*Figure 160: Deployment for the weak component*

Step 2 – Target definition

Reduce the number of breakdowns related to the heating element.

Step 3 – Analysis

In order to cut and weld the cellophane packaging material, the machine is equipped with three heating elements: two for welding and one for cutting. They are placed at a distance of two millimetres one to each other. This causes a materials' overheating. The problem occurring was the breaking of the heating element support and the heating element itself as well.

Step 4 – Solving action

We initially decided to look for a more resistant material, having with the following features:

- Heat resistance
- Electrical insulation
- Good hardness
We didn’t find a suitable and low-cost material. Therefore, we tried to change radically the welding system trying to work with a single heating element performing together the function of cutting and welding. This improvement allows a dramatic heating reduction and consequently reduces the wear of the heating elements and their supports. We performed tests and, after having had the approval by Quality Control around the quality cellophane wrapping, we proceeded with the modification.

**Step 5 – Results**

Thanks to this improvement, we didn’t have any breakdown on heating element as shown in the graphs below.
6.15 Results and Future Plans

The development of our KPIs is very positive.

Chart 44: Breakdown per year

Chart 45: Breakdown per 1000h run time
Chart 46: Improvement of the Breakdown Analysis done by our mechanics

Chart 47: Yearly Preventive Maintenance done
In the future, we will further go ahead with the route and the pillar methodology and we will focus on the following items:

- Improvement of the preventive maintenance programs on all lines according to the ABC machines classification and its management through the CMMS-CARL Software
- Continue with the BDA’s on all breakdowns and improve the quality of them
- Reduce the MTTR thanks to the new BDA format elements concerning interventions’ time
- Continue and intensify the collaboration between AM and PM pillar
- Transfer the management of spare parts warehouse on the CMMS-CARL Software
- Improve the skills of maintenance technicians in collaboration with the T&E pillar
CHAPTER 7
Training & Education
7 Training and Education

7.1 Basic Concepts and Priority Measures

The T&E Pillar has been developing its activities since September 2018. Before this date, there was a standard procedure related to the competencies evaluation (“pallinogramma”) of our factory staff and related training procedures but these data were a little too generic and subjective. Nowadays, the training process it is more precise and objective, and it is linked with the company mission and, in general, with the need of the losses eradication culture. Thanks to the skill matrix, we now have the current situation/condition of all the factory staff. This will help us to understand the workforce capabilities, the training needs of our plant and consequently how to react to fill the competence gaps.

7.1.1 Pillar Mission goals and main Activities

The Pillar’s Mission is:

- Verify existing skills for factory staff and eliminate progressively the losses caused by gaps of competencies, developing training experience and creating high participant involvement.

The Mission is directly linked with the following statement of our Plant Vision: “Become the most reliable and attractive partner for the Intercompany Business and Increase the Plant production volume by 10% every year”.

The Pillar’s objectives are:

- To be able to measure skills gaps;
- To have a detailed training plan;
- To carry out training to fill the gaps;
- To increase knowledge and develop the skills of each plant operator;
- To eradicate the losses having their root causes linked to the “Manpower and Method Ms”;  
- To support the other pillars.

In order to achieve these objectives, the T&E Pillar follows these steps:

- Skill matrix adoption;
- Competencies gaps assessment and periodic re-evaluation;
- Prioritization of the training;
- Development of both on-the-job and in classroom trainings;
- Standardization of the steps concerning the management of the training activities.

By following the pillar route (Figure 162), we have developed practical activities and processes to pursue our goals. In order to control our timetable, we developed our Masterplan (Table 24).
7.1.2 The Training and Education Pillar Team

Five members from different areas compose the Pillar team. We have chosen the members of the Pillar basing on the role covered in the company; because of the pillar cross activities it is essential to have an interfunctional team able to bring its own professionalism to the pillar.

The Pillar Leader is Alessandro Olivero who is the Human Resource Manager.
7.1.3 Pillar KPIs and KAI

The Pillar monitors different indicators on a monthly basis, which are grouped in KPIs and KAI, in order to verify the consistency of the pillar activities. The Table 25 shows the KPIs and KAI that are managed by the T&E pillar.

Table 25: T&E Pillar Indicators

<table>
<thead>
<tr>
<th>LEADER</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alessandro Olivero</td>
<td>HR Manager</td>
</tr>
<tr>
<td></td>
<td>Antonella Folegatti</td>
<td>Pay Office Manager</td>
</tr>
<tr>
<td></td>
<td>Simone Baretta</td>
<td>Mass &amp; Moulding Department Manager</td>
</tr>
<tr>
<td></td>
<td>Danilo Colletta</td>
<td>Industrial Performance Mgr</td>
</tr>
<tr>
<td></td>
<td>Stefano Vietti</td>
<td>LPW Specialist</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEMBERS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DRIVER</th>
<th>KPIs</th>
<th>Measure unit</th>
<th>Expected trend</th>
<th>Historical data</th>
<th>YTD 2019 (Jul)</th>
<th>Target 2020</th>
<th>Vision 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>KPIs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Competence gap in PB (Mass Production Department)</td>
<td>%</td>
<td>#N/D</td>
<td>22.0%</td>
<td>20.9%</td>
<td>22.0%</td>
<td>14.4%</td>
</tr>
<tr>
<td>P</td>
<td>Competence gap in MC (Moulding Department)</td>
<td>%</td>
<td>#N/D</td>
<td>17.8%</td>
<td>17.8%</td>
<td>10.3%</td>
<td>10.0%</td>
</tr>
<tr>
<td>P</td>
<td>Competence gap in AC (Wrapping Department)</td>
<td>%</td>
<td>#N/D</td>
<td>7.8%</td>
<td>7.8%</td>
<td>5.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>P</td>
<td>Competence gap in CO (Packaging Department)</td>
<td>%</td>
<td>#N/D</td>
<td>8.2%</td>
<td>8.2%</td>
<td>5.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>P</td>
<td>Man &amp; Method Losses vs total Losses collected on a daily basis</td>
<td>%</td>
<td>#N/D</td>
<td>55.9%</td>
<td>38.7%</td>
<td>55.9%</td>
<td>36.4%</td>
</tr>
<tr>
<td>P</td>
<td>% of blue collar evaluated through the skill matrix</td>
<td>%</td>
<td>#N/D</td>
<td>5.8%</td>
<td>89.7%</td>
<td>5.8%</td>
<td>89.7%</td>
</tr>
<tr>
<td>M</td>
<td>Completed training vs planned</td>
<td>%</td>
<td>#N/D</td>
<td>100.0%</td>
<td>#N/D</td>
<td>75.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>M</td>
<td>Training hours per each worker</td>
<td>h / operato</td>
<td></td>
<td>17.1</td>
<td>17.5</td>
<td>8.0</td>
<td>8.6</td>
</tr>
</tbody>
</table>
7.2 Determining Training Budgets

In order to schedule each training, the Pillar uses the Skill Matrix (See Chapter 9.3) and the losses analysis of each line/machine. Thanks to this Skill Matrix and Analysis, the training courses are developed by priority.

In order to schedule better our training activities, we have created an informatic system (Table 26) that allows the pillars to have under control all the training done or planned; it also allows the pillar to have the information about the training hours needed and the suitable trainer for that activity. Furthermore, this informatic system gives the possibility to the Heads of departments to ask for training activities: without this system the request could be lost.

Once we populate this file with the training needs of the plant, we create our projects plan with a better understanding of the priorities and consequent schedule (Table 27).

<table>
<thead>
<tr>
<th>Partecipante</th>
<th>Area</th>
<th>Reparto / Pilastro</th>
<th>CdL / Macro Argomento</th>
<th>Argomento</th>
<th>Tipologia Training</th>
<th>Formatore</th>
<th>Ore di training</th>
<th>Livello</th>
<th>Livello Target</th>
<th>Priorità</th>
<th>Data Ricevimento</th>
<th>Data Pianificata Erogazione</th>
<th>Data Erogazione</th>
<th>OTIF</th>
<th>Esito</th>
</tr>
</thead>
<tbody>
<tr>
<td>LERDA SAMANTA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEMATTEIS PATRIZIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGLI' CLAUDIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIPAMONTI BARBARA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAZZOLER CRISTINA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BESSON NADIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MONNET SILVIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALCI PAOLA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GONNET ADRIANA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BENEDETTO STEFANIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BERNARDI MIRIAM</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUOZZO LAURA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CERUTTI CRISTINA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BONTEMPO ELISABETTA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUMBOLO MARIA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GARAU MARIA FRANCESCA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASCIA LUISELLA</td>
<td>AM</td>
<td>AM</td>
<td>Elettrico</td>
<td></td>
<td></td>
<td>AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The training plan takes into consideration also the safety and quality training priorities in order to accomplish the Vision of our Safety and Quality priority which are “zero accidents” and “zero defects”, on top to be compliant with regulations.

### 7.3 Outline of training and education and methods to improve skills

Before the kick-off of the T&E pillar, there was a system named “pallinogramma” to track the abilities of our blue collars to work on a certain machine. This system was not so precise and suitable to assess the various competences needed of our employees; the idea behind was more to have, at first glance, a tool for the workforce planning and distribution. From 2018, the Pillar has structured the process of skill matrix system from which the gaps of knowledge can be easily noticed as well as the training needs.

During the last year, the pillar members, the heads of departments and even some operators, have worked side by side to map the competencies, using our check lists to assess the level of knowledge of each operator. Since 2018 until the end of 2019 we have mapped 204 out of 237 total blue collars. Our goal is to cover all the factory operators within 2020.

### 7.3.1 Development and Implementation of Competencies System

The first activity of the Skill Matrix System has been the creation of a checklist (*Figure 164*) for each competence that in our System can be technical skills linked to a specific machine or competences about 5S, or SAP ERP system. These checklists are statements divided by levels

---

**Table 27: 2020 Projects plan**

<table>
<thead>
<tr>
<th>CATEGORIA PROGETTO</th>
<th>NOME DEL PROGETTO</th>
<th>AREA DI APPLICAZIONE</th>
<th>Percorso</th>
<th>Leader e Co-Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formazione macchinista su ACMA</td>
<td>MC171</td>
<td>Competence Gap Reduction</td>
<td>S.Baretta</td>
<td></td>
</tr>
<tr>
<td>Formazione su uso ICS</td>
<td>PD-MC</td>
<td>Competence Gap Reduction</td>
<td>S.Baretta</td>
<td></td>
</tr>
<tr>
<td>Formazione su Temperatrici</td>
<td>TC</td>
<td>Competence Gap Reduction</td>
<td>F.Allaix</td>
<td></td>
</tr>
<tr>
<td>Formazione su uso Radiofrequenza</td>
<td>Generale</td>
<td>Competence Gap Reduction</td>
<td>F.Travers</td>
<td></td>
</tr>
<tr>
<td>Formazione su 5S</td>
<td>Generale</td>
<td>Competence Gap Reduction</td>
<td>S.Vietti</td>
<td></td>
</tr>
<tr>
<td>Formazione gestione Autocertificato</td>
<td>Generale</td>
<td>Competence Gap Reduction</td>
<td>G.Martina</td>
<td></td>
</tr>
<tr>
<td>Formazione Macchinista su Jointech</td>
<td>CO0865</td>
<td>Competence Gap Reduction</td>
<td>M.Cavaliere</td>
<td></td>
</tr>
<tr>
<td>Formazione Capo linea su ITECH</td>
<td>CD1983</td>
<td>Competence Gap Reduction</td>
<td>S.Vietti</td>
<td></td>
</tr>
<tr>
<td>Seidone Raffine</td>
<td>P01717-P01810</td>
<td>Competence Gap Reduction</td>
<td>S.Baretta</td>
<td></td>
</tr>
<tr>
<td>Visual Improvement communication</td>
<td></td>
<td></td>
<td>E.Giraudo</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>#5</td>
<td>Competence Gap Reduction</td>
<td>M.Ghigonetto</td>
<td></td>
</tr>
<tr>
<td>Seidone Fusore Grassi</td>
<td>PB</td>
<td>Competence Gap Reduction</td>
<td>M.Ghigonetto</td>
<td></td>
</tr>
</tbody>
</table>
of complexity. The levels of evaluation are five, being 5 the highest level. In the Skill Matrix System (Table 29), we have also mapped the starting point (S) which means the level assessed of each operator at the beginning of the Pillar activity, the current level (C) which means the level assessed at the latest evaluation (once a year) and finally the target level (T) defined by the Head of Department.

The Table 28 shows the meaning of each level.

Figure 164: Checklist for ACMA

Table 28: Levels of evaluation

With the second activity we have filled in the Skill Matrix with the results of each blue-collar evaluation made with the checklists (Table 29).
The third activity has been the creation of the Radar Charts. These charts show the overall results of the Skill Matrix.

The priority training needs can be easily identified through Radar Charts. We have built up two Radar Charts. One Radar Chart (Chart 48) can show the levels of all operators related to the single competence/machine. The second (Chart 49) one can show the competencies of each operator in every competence/machine.
The fourth activity has been to create a digital system to prioritize the training needs. In order to achieve this objective during 2019 we created a system to define which were the most critical machines in the plant. The criteria to evaluate the machines are five:

- Number of Adjustments done by the Technicians,
- Number of problems with a root cause linked with Manpower and Method, identified during the Factory Daily Meetings using the Ishikawa Method,
- Saturation of the line,
- OEE,
- Machine’s crew size during run-time

Each one of this criteria has a different importance in the calculation of the priority (Adjustments and root causes are the most important with a specific weight of 30% while the Crew size (number of operators) is the less important with a specific weight of 5%), and all together support the definition of the training priorities of the plant (Table 30).

After we having prioritised the machines, we select the operators that have to be involved in the trainings using the Skill Matrix System (Table 29), analysing the gaps on all the competencies required on that machine.
As shown in the previous table, we have already identified the critical areas with the highest training priorities; hence, we have all the information for defining and developing a training program.

Before the T&E pillar launch, the training courses were anyway developed and the training hours were also registered, however the Human Resources Department did not have enough information about the training needs.

Consequently, there was not a prioritization of which training should have been developed and we did not consider the efficacy of the training itself.

To standardize the gap reduction, the T&E Pillar has developed a standard route and standard formats to be used during the trainings. The route is based on ten steps:

**Figure 165: Route for the Competence Gap Reduction**
We have created standard documents such as an attendance sheet, a verification test at the end of the training, technical manuals for internal use, training sheets for training on the job (SOP; OPL) and an evaluation sheet of the course and the instructor.

We provide trainings starting from the gaps coming out from the Skill Matrix System. In the step 7 of our Gap reduction route, we arrange the type of training based on the actual levels and the targets that the operators have to reach; so right now, our trainings are customized as the needs of the trainees.

Once the employee completes the training activities, he/she will be assessed again using the same checklist used before the training (Figure 166) and verifying the level reached (Figure 167). The assessment is conducted by the Trainer himself.

If the employee doesn’t reach the target level, he/she will have to attend the training again and having another assessment.

*Figure 166: Checklist before the training*
7.3.2 Training Facilities

We organize different types of training in order to close the gaps between current and target level of knowledge.

These training courses can be done in a classroom, in the Training Room or in the work place for the on-the-job training. The next pictures show some examples of training.

Training in Classroom:

- Theoretical Training (Example: 5S Training, Quality Training, etc.)
- Procedure’s explanation (Example: Safety Training)
**Training Room:**

- Theoretical trainings supported by practical examinations
- AM Step 4 Training: Electrical system, Transmissions, Lubrication and Basic Mechanics

*Figure 169: Practical and Theoretical training in Training Room*

**On the Job:**

- Practical training for blue collars (Example: AM Step 4, Coaching, etc.)

*Figure 170: Mechanical and Electrical Training on the job*

*Figure 171: Training Room*
The Training Room was fully equipped at the beginning of 2019. Its creation was primarily to develop the AM step 4 training, that was divided in theoretical and practical lessons. In this room, some mobile panels support the technical trainings of basic mechanics and basis electric components and a workbench is used to teach how to use different tools that are in the production area.

We have equipped the training room with a screen connected with a PC in order to show the training materials such as OPL / SOP / videos dedicated to the training topics.

### 7.4 Evaluation of maintenance work knowledge and skills

The T&E Pillar has started to map all the skills of the Maintenance Department (mechanic and electrical technicians). The process started at the end of 2019 updating the 3 skills matrix (Table 31) and the 65 existing list of competencies. Our aim is to approach the Maintenance Department adopting the same method and process as for the other departments. That’s why in our Master Plan we have planned to create the check list dedicated and to assess our Maintainences operators during 2020.

We will start filling in all the check list for each technician together with PM Pillar, and create the Maintenance Skill Matrix. The second step will be to define the skill gaps and the further step will be to create a specific training plan for the Maintenance Operators.

<table>
<thead>
<tr>
<th>Table 31: Maintenance Skill Matrix on the Mass Preparation Department and Moulding Department (before the launch of T&amp;E pillar)</th>
</tr>
</thead>
</table>
| **PASTA BASE - MODELLAGGIO**  
(area calda)  |
| **MAINTENANCE SKILL MATRIX**  
Agg 10/12/2007  |
| **NOME**  |
| **ANGELINO MASSIMO**  |
| **ARTUS GIANCARLO**  |
| **RAFALE LOIS**  |
| **BERTONE ANDREA**  |
| **BOVERO VALTER**  |
| **CARLE MARCO**  |
| **MECCANICO**  |
| **ELETTRICO**  |
| **ELETTRONICO**  |
| **PNEUMATICO**  |
| **IDRAULICO**  |
| **MEDIA**  |
| **ERGONOMIA**  |
| **DIAGNOSI PROBLEM SOLVING MODIFICHE MIGLIORATIVE LEGENDA**  |
| **ATTUALE**  |
| **INIZIO**  |
| **OBBIETTIVO**  |
| **GAP <= 1**  |
| **GAP <= 2**  |
| **GAP <= 3**  |
| **GAP <= 4**  |
7.5 Qualified specialists

In order to reach the Plant Vision, the T&E pillar works together with the others pillars to eliminate the losses. With this goal T&E pillar works side by side with the others pillars to create methods and tools that are currently necessary; furthermore T&E pillar helps the other pillars to form qualified specialists in each field of the company. To do that, T&E carries out trainings in order to improve the knowledge and the competencies of the employees.

In Table 32 some examples of the connections between T&E and the other pillars are reported:

<table>
<thead>
<tr>
<th>Link between T&amp;E and the others pillars</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&amp;E AM PM T&amp;E supports AM in educating employees during the step 4</td>
</tr>
<tr>
<td>T&amp;E SAF T&amp;E supports SAF in educating employees on the Safety issues</td>
</tr>
<tr>
<td>T&amp;E PM T&amp;E will support PM in the training of the Maintenance operators</td>
</tr>
<tr>
<td>T&amp;E EEM T&amp;E will support EEM planning the training for the new lines</td>
</tr>
<tr>
<td>T&amp;E T&amp;E The pillar needs to educate trainers that can carry out the training in the departments, good trainers are essential for the success of the T&amp;E Pillar</td>
</tr>
</tbody>
</table>

7.5.1 Example for Specialist of T&E Pillar – Educated Trainers

T&E Pillar needs qualified specialists to do the training courses and above all to spread the TPM culture to all employees. T&E pillar has started to capitalize the existing knowledge particularly of one of our Maintenance Technicians and one of our Front-Line Managers giving them a structured method and flow to let them to be prepared to train other operators.

One of the major issues that we met, has not been to properly set the qualified specialist but to let them to transform their role from specialist to trainer. This means to transform their approach, mainly avoiding that they do not take too many things for granted.

Therefore, we invest on a web-based assessment (named TT Success Insight) to evaluate behaviours and motivation drivers of our qualified specialists in order to coach them in making clear even sophisticated concepts and activities and to let them to evaluate quickly their audience.

For the future developments T&E Pillar is approaching the TWI method to go on in this direction.
Chart 50: Behavioural Aspects

Chart 51: Motivation Insights

Chart 52: Behavioural Aspects
7.6 Examples of training/education materials and effects

Our pilot project chosen, developed not only to face the gaps reduction and losses eradication but also to evaluate the efficacy of the method, was “Mondialpack Training”.

We chose this training because Mondialpack at that time was a bottleneck machine; furthermore there were a lot of mechanical interventions or adjustments (Figure 172) and the performances in that machine were below the expectations (Figure 173).

After we created the checklist (Figure 174), we saw that the skills of the operators did not meet the required ones; this difference is highlighted by the skill gaps (Figure 175).
Together with an internal Trainer (Electrical Maintenance Specialist) we developed the training materials, as SOPs and OPLs (Figure 176) and its agenda. The Master Plan of the training is shown in the Figure 177.

**Figure 174: Mondialpack Checklist**

**Figure 175: GAP created after the evaluation on the checklist and the target for each operator**

**Figure 176: Training material (SOP)**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Position the selector in &quot;AUTOMATIC&quot;</td>
</tr>
<tr>
<td>2.</td>
<td>Align the film after replacing the bobbin</td>
</tr>
<tr>
<td>3.</td>
<td>Pull the film in &quot;MANUAL&quot; using the selector TRAIN FILM</td>
</tr>
<tr>
<td>4.</td>
<td>Ensure that you have the correct receipt, otherwise follow SOP IEMC09_2018</td>
</tr>
<tr>
<td>5.</td>
<td>Push the button RESUME to allow the continuation of the activities</td>
</tr>
<tr>
<td>6.</td>
<td>Select the selector CYCLE AUT - 0 -MAN from the center to the right (MANUAL) and repeat the operation multiple times (moving from 0 to MANUALE) until reaching the desired seam alignment.</td>
</tr>
</tbody>
</table>

After we performed the training, we noticed excellent results both in the line’s performances (Chart 53 and Chart 54) and competencies gap (Chart 55)

Chart 53: Technical Efficiency after the training
7.7 Results achieved and Future Plans

After one year since its kick-off, T&E Pillar has mapped 80% of the operator/blue collars of the plant. Our goal is to conclude the mapping in 2020 (Table 33) and to expand our approach to the entire Company (not limited to Operations field).
One of our main goals is to collaborate with the others Pillar to reduce our losses and to increase our efficiency in order to get the Plant target. We also improved our data collection and the link between the losses and the competencies gap inside the plant, helping the pillar defining the priorities (Table 34) and the projects that will be launched in the next years. Moreover, we want to enter more deeply in the company vision creating standard trainings for new machines, helping the EEM pillar in the launch of new lines.

### Table 34: Prioritization System

<table>
<thead>
<tr>
<th>CdL</th>
<th>Descrizione CdL</th>
<th>Saturation</th>
<th>OEE</th>
<th>N° Adjustments</th>
<th>N° 4M (Man e Method)</th>
<th>% of incidence on the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC0701</td>
<td>LINEA VASETTI</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>20%</td>
</tr>
<tr>
<td>CO0865</td>
<td>CONFEZIONATRICE JOINTECH J200E</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>15%</td>
</tr>
<tr>
<td>MC0521</td>
<td>WINKLER &amp; DUNNEBIER</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>30%</td>
</tr>
<tr>
<td>AC0332</td>
<td>AVVIL CIOCC VARI CORIMA AFCP</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td>MC0171</td>
<td>AVVIL ACMA</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>CO1055</td>
<td>LINEA DI PES E CONF ITECH/CMG</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>20%</td>
</tr>
<tr>
<td>PB0618</td>
<td>LINEA MESC.RAFF.IMPASTI CIOCC</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>MC0170</td>
<td>DELVER</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>CO0247</td>
<td>LINEA PESATURA SIMIONATO 1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td>MC0810</td>
<td>F.A.G.</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>5%</td>
</tr>
<tr>
<td>CO0405</td>
<td>CONFEZIONATRICE NEPAL</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5%</td>
</tr>
<tr>
<td>MC0286</td>
<td>LINEA DELVER CORPI CAVI/UOVA</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>AC0350</td>
<td>AVVIL IPAC AFC</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>20%</td>
</tr>
<tr>
<td>CO0337</td>
<td>LINEA PESATURA SIMIONATO 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>15%</td>
</tr>
<tr>
<td>MC0111</td>
<td>NUOVA BINDLER</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>15%</td>
</tr>
<tr>
<td>PB0029</td>
<td>TOSTINO NOCCIOLE</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td>AC0161</td>
<td>AVVIL RASCH RUN220</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>10%</td>
</tr>
<tr>
<td>PB0617</td>
<td>LINEA MESC.RAFF.GIANDU.E RIP.</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>MC0294</td>
<td>COLAGGIO GIANDUIOTTI</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>20%</td>
</tr>
<tr>
<td>AC0085</td>
<td>AVVIL IPAC</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>10%</td>
</tr>
<tr>
<td>CO0583</td>
<td>LINEA PESAT./CO.SYSTEMPACK</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>MB0631</td>
<td>LINEA COTTURA/COL.PR.IN AMIDO</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>AC0173</td>
<td>AVVIL IPAC AFC</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>AC0134</td>
<td>AVVIL IPAC</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>MB0632</td>
<td>LINEA ZUCCHERATURA GELATINE</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>AC0722</td>
<td>AVVIL RASCH TIPO RU</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>CO0448</td>
<td>CONFEZIONATRICE CAVANNA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>AC0121</td>
<td>AVVIL RASCH TIPO RU</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>CO0561</td>
<td>LINEA DI IMBUT. ALL.(C.CAVI)</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>5%</td>
</tr>
<tr>
<td>MC0670</td>
<td>LINEA DI RICOPERTURA SOLLICH</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>CO0406</td>
<td>CONFEZIONATRICE NEPAL 2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5%</td>
</tr>
<tr>
<td>CO0480</td>
<td>TAPPETO N.3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>5%</td>
</tr>
</tbody>
</table>

#### 7.7.1 Future Plans

- Complete the skill matrix in all the Operations area,
- Enhance the operators’ awareness on the link between the losses and the competencies gap,
- Implement training activities to reduce skill gaps and losses,
- Improve the synergy between T&E Pillar and other Pillars to better drive the training process.
CHAPTER 8
TPM Effects and Evaluation
8 TPM Effects and Evaluation

8.1 Tangible Effects

8.1.1 TPM Effect from Overall Management Viewpoints

Since the introduction of the TPM methodology at the end of 2013 (with the roll-out of PCS and 5S) crucial changes in the way of working and managing the plant have occurred in our factory. The awareness of product quality and the mentality “do it right the first time” have significantly increased.

Both management and operators have learned to approach problematics in a structured way, in order to find a permanent solution to really eradicate the problems, we build a culture focused in a “first time right” approach, giving to all people involved in TPM a structured program ready to give the correct tools achieve our goals. This mentality is steadily strengthened with the increasing T&E efforts about our equipment and products.

In addition, TPM has helped to standardize procedures and documents across departments. Before the introduction of TPM, departments were managed as individual entities, and all of them worked with different tools and different approaches, making harder to work with other department and offices. However, by encouraging cross-functional team collaborations (Production, Planning, Quality, Safety, Maintenance and Engineering, R&D), a common route on how to approach the problems, implementing the collaboration between all the functions and improving the reaction time when problems occur.

8.1.2 TPM Effect on Production (P)

The TPM activities effects directly Production in two KPIs:

- Overall Equipment Effectiveness (OEE)
- Productivity (kg produced / manpower hour spent)

Both of them are by Department, and as shown by the charts below, we increased both KPIs since we started the TPM activities. Particularly relevant are the increased productivity on the whole plant and the OEE of our spread filler line.
Chart 56: Plant Productivity since the start of the TPM activities

![Plant Productivity Chart]

Chart 57: Increasing of the OEE in the Mass department

![OEE Mass Department Chart]
Chart 58: Increasing of the OEE in the key lines of the Moulding department

Chart 59: Increasing of the OEE in the key lines of the Wrapping and Packaging departments
8.1.3 TPM Effect as seen from Quality (Q) Viewpoints

Caffarel is positioned in the premium chocolate market. For this reason, the quality of our products is essential to play a role in the market. In order to give the best product to our customers, we always work with a high level of Hygiene control to prevent any cross-contamination between the different products.

Essential for the improvement of the Quality of our products are consumers feedbacks. That is why we always encourage the consumer to remark even the tinier “non-conformities” in order to help us put in action the correct countermeasures to correct those “non-conformities”. To understand the evolution of the Quality Caffarel uses three KPIs:

- Consumer Complaints / 1000 tons
- Waste & Rework (%)
- Non-Conformities / 1000 tons

The increasing number of the internal non conformities in 2017 is due to the fact that before there was not a system to track these non conformities (the system was created in September 2016).

The data of the rework (chocolate non perfect which is reused in another receipt since the mixing phase) is growing because the R&D is creating a lot of receipt to reuse chocolate that before was non recoverable. For this reason, is more interesting see the two indicators (Rework and Waste) together, this indicator is still decreasing which is a good result as a lot of new products were created in the past few years.

Chart 60: Complaints and non-conformities reduction

Chart 61: Waste and Rework reduction
8.1.4 TPM Effect on Cost (C)

To monitor the impact of the TPM on the cost Caffarel monitors two KPIs:

- Direct Cost (€ / Tons)
- Indirect Cost (€ / Tons)

This KPIs are monitored by the FI pillar many teams were launched in the past years in order to reduce the labour costs, the results of those teams were incredible, as we can see in the charts below Caffarel is reducing the cost every year since the program started in 2014.

*Chart 62: Direct Labour cost per ton produced*

![Direct Labour cost chart](chart.png)

*Chart 63: Indirect cost per ton produced*

![Indirect cost chart](chart.png)
8.1.5 TPM Effect on Delivery (D)

Since 2015 Caffarel started to measure two KPIs regarding the delivery, the Case Fill Rate in order to satisfy our client requirements and the 3rd Party on time in full. Thanks to this action we saw that the Case Fill rate grew by 0,5% since the beginning of TPM, furthermore the delivery on time to 3rd party has grown by 21%. To improve these KPIs we worked on eliminate all the possible obstacles in the process.

*Chart 64: Case Fill rate*

*Chart 65: 3rd party in full*
8.1.6 TPM Effect on Safety (S)

The main goal of Caffarel is to assure that all the employees stay healthy and do not experience any harm through environmental impacts or accidents at the workplace. For this reason, we monitor all the lost time accidents (accidents requiring days off working) and the First Aid (not anyway requiring days off working), with the TPM program our goal is to create a safer environment encouraging the employees to report every unsafe condition and every unsafe behaviour in order to put in place the most correct and adequate countermeasures.

*Chart 66: Lost time Accidents since the TPM start*

*Chart 67: First Aid reduction*
8.1.7 TPM Effect from Morale/Training (M) Viewpoints

Since we do believe it is crucial for the development of the TPM in the company, we monitor the people involvement in the plant activities. Increasing morale and health related activities contribute concretely to the decreasing of sick leave rates.

*Chart 68: Sick leave reduction*

*Chart 69: Turnover in the Operations*
8.1.8 TPM Effect on Environment viewpoints

The TPM effect directly also the environment, and we can measure it through two KPIs: the water and energy consumption. The structured approach of the TPM gave Caffarel the possibility to better identify the losses helping the company to improve the environmental KPIs. Caffarel is proud to be the first plant in all the Lindt & Sprüngli Group to be carbon free as shown in Figure 178.

*Figure 178: Energy origin in Caffarel*

**ELECTRICITY (since 2013)**
- from hydroelectric power plant in Aosta Valley
- 46% of total energy

**GAS (since 2018)**
- from biogas plant in Pinerolo
- 15% of total energy

**HOT WATER (since 2017)**
- from biomass power plant in Luserna San Giovanni
- 39% of total energy
Chart 70: Water consumption reduction per ton produced

Chart 71: Energy consumption per ton produced
8.2 Intangible Effect

Caffarel believes that a company culture can be built only if all the employees follow the same credo and vision and they are involved in the decision process on a daily basis. Thanks to the structured TPM that we built in the past five years we believe that we achieved the goal of creating a unanimous shared route to reach the common goal.

Caffarel also believes that the creation of KMI s and KPIs gave the opportunity to the company to better understand were the losses were located. The building of these targets allows the achievement of individual goals and gives every employee the opportunity to contribute to the success of the company actively. Every single employee impacts the business and now everybody can see the results of his/her contribution.

Below some intangible effects related to the TPM:

- Standardized working process for the whole plant
- Creation of a work environment that allows the individual to get involved
- Creation of the Kaizen mindset in the employees
- A positive attitude towards tidiness and cleanliness and hence increasing Food Safety conditions
- Improved cross-function communication
- Structured approach
- Better understanding of the priorities, analysing the performances by number and not by sensation, avoiding any subjectivity

8.3 Issues of Present Practice and Counter-Measures

The key to the TPM Program “LPW – Lindt Production Way” is the shared ambition to improve in the daily activities. To meet the pressure of cost increases, Caffarel needs everyone to contribute to positively impact OEE and productivity development of the production lines in order to become more profitable and more competitive on the market.

We want to extend the our TPM program in all the areas of the company, also the ones, outside Operations, that, at the moment, are not completely involved in the structure.

One issue related to the Operations area is the contribution of seasonal workers. This issue has an impact as new seasonal workers have no competence around the production process and very short time to learn. In order to get the seasonal workers immediately involved in the TPM activities (Kaizen mentality, AM involvement and 5S) and to learn faster the skills to work on machines, we find very useful the OPLs and SOPs to train all the new operators in a standardized and structured way.

Challenges in our TPM program, besides the future activities of each pillar, will be:

- Involve all employees in daily TPM activities with a strong focus on employee safety and product quality
- Roll out TPM office activities in all Operations departments as well as in administrative departments
- Increase and intensify the communication in order to promote the zero-loss mentality
- Implement our data collection to have more information about what affects the performances

### 8.4 Vision of 21st Century and their Implication for TPM

With a market that in the past years has become always more competitive in the premium chocolate market, a company like Caffarel needs to be more profitable. We do believe that, through the TPM full implementation in the company, with the loss reduction and the performances improvement, we will become a more reliable company for the Intercompany business that is already the majority of our production. As the margins for the Intercompany business are lower than the ones that we have with the Caffarel products, the TPM activities will become crucial for the development of the company in reducing the non-value-added activities and increasing the efficiencies in the factory.

The expertise and abilities of Caffarel’s employees will be the key to achieve these goals in a cost-efficient way. With TPM, Caffarel will further increase the knowledge of its workforce through advanced autonomous maintenance, planned maintenance and progressive quality activities.

In order to have always more reliable data, one of the future plans for Caffarel is to implement the use of the MES in all the lines doing that we will have the real reasons behind every loss in the plant that will lead to a better prioritization of the actions that each pillar most take to improve the overall performances.
9 Ringraziamenti

Vorrei prendermi un minuto per ringraziare tutte le persone che hanno reso possibile questo mio percorso:

Il Professor Schenone per l’aiuto e il supporto nella stesura di questa tesi, i suoi consigli sono stati essenziali per il risultato finale.

La mia fidanzata Arianna per avermi supportato e sopportato durante tutto il percorso accademico e per essermi stata vicina anche nei momenti di difficoltà e di lontananza geografica. Grazie per avermi consigliato lungo tutto il mio percorso e per avermi aiutato prendere le decisioni giuste per me.

I miei genitori per aver reso possibile questo mio percorso, non solo dal punto di vista economico, ma anche per aiutato a non accontentarmi mai.

Le mie sorelle Elena e Marta che mi hanno sempre aiutato nelle decisioni che ho dovuto prendere sia nel mio percorso accademico che in quello lavorativo. Per me siete state un grande esempio da seguire, grazie per avermi spinto a dare sempre il massimo.

Gli Amitici (Chiara, Gau, Ale, Bud, Obi, Ucin, Giulia, Mari, Ele, Jack, Luca, Albi, Fedo, Fra, Isa e FP) che nei momenti di stacco dallo studio mi hanno sempre offerto momenti di gioia e divertimento.

Alex e Ste con cui ho condiviso il mio percorso, lavori di gruppo e momenti di svago.

Danilo che come mio tutor in Caffarel mi ha insegnato tanto sul mondo del lavoro e mi ha aiutato a mettere in pratica tutto quello che avevo imparato al Politecnico. Sei stato essenziale nel mio cammino in Caffarel. Mi hai dimostrato affetto e fiducia sin dal primo giorno, mi hai dato esempio di come affrontare tutte le difficoltà che si presentano tutti i giorni in un’azienda.

Caffarel che mi ha dato fiducia prima ancora di essere laureato e mi ha permesso di mettermi in mostra all’interno dell’azienda.

Il Politecnico di Torino che mi ha permesso di fare un percorso di studi estremamente interessante con gli anni all’estero e i tirocini che mi hanno permesso di entrare nel mondo del lavoro.