Implementing a lean production system on a food company: a case study

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Abstract: This paper describes a project to increase a food manufacturer’s productivity by applying several lean production techniques to the company’s manufacturing organisation, production quality and efficiency. The company has decided to improve several specific sectors within their factory, where deficiencies and lack of productivity were observed in some of their work lines. This work shows the lean system implementation on the company: from the initial diagnosis, the improvement plan proposed and how it was implemented, to an analysis of the results obtained. Final recommendations made to the company dealt with the lean culture and its work and production methods, in order to be gradually implemented in the whole company.

Keywords: continuous improvement project; productivity analysis; lean production techniques and tools; lean indicators.


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1 Introduction

Nowadays, most companies are forced by competitors and markets to find solutions within their management systems to respond to such challenges as: fast delivery times; development and innovation of new products; more frequent, smaller-batch shipments; a decreasing trend in prices; zero defects and total reliability of their products (Suarez et al., 1995; Espejo and Moyano, 2007).

This new scene has brought about a search for new alternatives in management models focused on the best company’s competitive position by way of guaranteeing the fulfilment of customers’ needs. A higher tendency has been detected towards the adoption of the lean production model principles, which affect companies not only internally, but also in their external organisation (Shah and Ward, 2003).

This new organisational model is a consequence of the pressing need to serve smaller markets with a wider range of products, which requires a greater degree of flexibility in production. For this reason, its main goal is to develop operations with minimal cost and zero waste. This is why it tries to act on the causes of variability or losses (that is, everything that does not increase the value as seen by the customer) and on the causes of inflexibility (that is, everything that does not adapt to customers’ requirements) to obtain an improvement in quality, costs, delivery times and production times (Womack et al., 1990; Womack and Jones, 2002).

By using this model, companies adopt a management philosophy based on continuous improvement, which offers the possibility of improving the results and involves all levels of the organisation. It means a radical orientation towards service quality and customers’ points of view (Cuatrecasas and Olivella, 2006; Espejo and Moyano, 2007).

In this paper, the research team has worked with a consolidated Spanish food producer operating at national and international levels, specifically in the sector of production, selection and packaging of spices, condiments and powder dessert mixes.

In the last few years, the company has undertaken a process of continuous improvement and has decided to take steps to improve several specific sectors within their factory, where deficiencies and lack of productivity were observed in some of their work lines, critical to maintaining the company’s competitive advantage.

This paper is structured as follows: Section 2 introduces the lean production approach and the tools selected for the company; Section 3 describes the lean system implementation on the company: from the initial diagnosis, through the improvement plan proposed and how it was implemented, to an analysis of the results obtained.
Lastly, Section 4 presents the conclusions and some recommendations to be taken into consideration by the company in the forthcoming years.

2 The lean production approach

The terms lean production and lean management have been used by Womack et al. (1990) to refer to Toyota production techniques. The underlying philosophy had been previously publicised in Western countries as just-in-time (Sugimori et al., 1977). The principles of this approach are the struggle against wasting resources in activities that do not add value for the client and the better use of personnel’s experience and intelligence through versatility and continuous improvement (Levonson and Rerick, 2002; Womack and Jones, 2002; Cuatrecasas and Olivella, 2006).

Lean production, together with the exposed principles, entails a set of production management tools (Womack and Jones, 2007; Santos et al., 2006) which, when correctly and completely implemented, can lead a company to success, thanks to important improvements in efficiency and competitiveness, the ultimate goal being to generate self-improvement dynamics within the company (Cuatrecasas and Olivella, 2006).

The lean techniques chosen for productivity improvement in the company studied are sorted out into the following three groups (Shah and Ward, 2003; Sharma, 2003; Hobbs, 2004; Rajadell and Sanchez, 2010):

2.1 Tools for production organisation

*Human organisation of production (HOP)* is a standard description of how to organise staff for production processes, its target being that all operators, supervisors and support personnel taking part in production processes are structured in a pyramidal configuration but allowing for an active, two-way flow of information, that is, from managers to operators and vice versa, thus supplying what is required for the achievement of planned goals.

*Staff implication* in the improvement project is obtained by using various tools: implementing the 5S methodology (a quality technique based on order, tidiness and good work habits); promoting simple, easy ideas (i.e., continuous improvement) resulting from daily teamwork, the implementation of which is not excessively expensive; and workers’ versatility, which seeks the team’s autonomy by better training each of the operators in the various tasks or workstations around them).

*Communication system* refers to the implementation of periodic meetings at the start of a working day, where necessary information is exchanged in order to achieve the targets set. In this project, three types of meetings have been specified, with different lengths and frequencies: TOP 5 is a daily 5-min meeting of a whole independent work group to share information on every aspect of a working shift. TOP 45 is a weekly 45-min meeting attended by all staff directly or indirectly involved with a particular piece of machinery being analysed. TOP 60 is a weekly 1-h meeting led by an area manager for efficient decision-making (indicators check, PDCA plans monitoring, etc.)
2.2 Tools for the progress of production quality

Setting up a quality system efficiency (QSE) is one of the key elements in lean production. Relying on workers’ contributions, this system makes it easier for a company to control and improve its target quality levels. Based on each operator’s deep knowledge of quality requests, this method tries to reduce the number of defects to zero, as well as to respond quickly to any incidence (PDCA action plans).

The QSE tools chosen for this project are:

- **Indicators**: They allow monitoring of quality evolution in every job according to the targets set. These are key elements at the time of making decisions.
- **Defects note board**: This is a wall exhibitor with photos, or even parts, displaying the main well-known defects. Using simple language, it helps the area personnel to chase the target by spotting the most common defects of a certain part/piece and to try to minimise it. In this way, it will be a high-level control area.
- **Red containers** are used to dispose of parts which do not meet the quality specifications required to be moved on to the following work phase. The defects found are analysed so as to eliminate them from the production process.
- **Poka Yoke** is a simple and trustworthy device intended to avoid errors, its target being to stop faulty parts from moving on to the next process, which would mean extra costs, and to guarantee operators’ safety when dealing with all kinds of machinery, process or procedure.
- **Quick response quality control (QRQC)** consists of taking daily actions to solve any kind of non-quality problems, and in doing so, learning lessons for the future.

2.3 Tools for efficient production

One of the most interesting techniques used in this group of tools is the overall equipment effectiveness rate (OEE), which is an indicator of the productive efficiency of industrial machinery. Reporting on losses and bottlenecks in every process, this calculation not only allows taking financial decisions but also making decisions on the efficient performance of factory operations.

The OEE indicator is made up of three factors:

- **availability**, which includes losses caused by stops, breakdowns, line setup and adjustments
- **output**, which includes losses due to microstops and speed reductions
- **quality**, which includes losses arising from start-up rejections and production rejections.

Another tool used is the problem-solving group, implementing and putting into practice lean techniques (SMED and TPM) by means of PDCA actions. The SMED method has been used to minimise both batch sizes and setup times of machines and materials. By recording and monitoring microstops, their length and frequency can be investigated to confirm whether the improvement actions implemented are being effective and may eventually lead to the disappearance of these microstops. Total productive maintenance
(TPM) is a work methodology whose target is to have zero breakdowns and make the production process less dependent on the maintenance department.

3 Implementing the lean production system on the company

Throughout the years, the lean management system has been put into effect in different companies and sectors, mostly as a process of trial and error. As several authors (Filippini et al., 1998; Spear and Bowen, 1999) point out, there is no unique implementation pattern, and processes cannot be extended from one experience to another.

According to Filippini et al. (1998), the differences between improvement proposals depend on whether the modifications only affect machinery and production teams, or the whole company structure, and also on whether the company adopts the new production techniques partially or completely.

But implementing lean on a productive system is a complex task, which goes beyond the implementation of specific techniques (cell layout, Kanban, SMED, etc.), to include a human dimension (level of commitment of both staff and management, change of the company’s values, etc.) lean production changes people’s way of working, making their jobs more challenging by giving more responsibility to the lower ranks of the organisation (Womack et al., 1990; Cusumano, 1994; Gagnon and Michael, 2003; Suzuki 2004).

In the case presented in this paper, for the execution of the lean production system and the chosen techniques, the methodology proposed by Fortuny-Santos et al. (2008) has been adapted. However, given the short period of implementation of the project and the situation of the company at the time, only the first stages proposed by these authors have been carried out. The research team has selected this methodology because it is based on training the company’s staff.

Figure 1 shows the phases of the implementation project within the company, as well as the calendar for its development and completion.

3.1 Initial diagnosis

The company in this case-study is provided with several production lines. Line ‘E’ was chosen for the improvement project because it accounts for the largest part of the company’s turnover, so its optimisation would result in a substantial increase in revenues.

The main feature of line E is that a total 27 references are prepared and packed in it, principally aromatic herbs and spices (oregano, parsley, black pepper, white pepper, garlic salt, curry, etc.) As for its work team, line E is allocated four workers in each of its three shifts (morning, evening and night), as well as a technical team (responsible for maintenance and quality in every shift).

In order to implement the lean production system, the company must know the initial situation of line E by studying its operation and trying to spot the reasons for the existing problems.

Machinery breakdowns in line E were Pareto-analysed, and the breakdown areas to be improved were identified: 80% of the analysed breakdowns were caused by stops in Sleever Machines, totalling 675 min/month (53.4%), followed by the capper with 175 min/month (13.8%) and the conveyor grouper with 165 min/month (13%). Therefore,
these machines are at the core of the project (Figure 2), as their malfunction means that the company is failing to produce 203,000 finished units in any given month.

**Figure 1** Phases of implementation of the lean production tools (see online version for colours)

<table>
<thead>
<tr>
<th>PROJECT MANAGEMENT</th>
<th>NOV</th>
<th>NOVEMBER</th>
<th>DECEMBER</th>
<th>JANUARY</th>
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<tbody>
<tr>
<td>1. PLANNING</td>
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<td>2. PRODUCTION ORGANISATION</td>
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<td>A.1. HUMAN ORGANISATION OF PRODUCTION</td>
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<td>Re-definition of roles</td>
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<td>KPI Implementation in line and monitoring</td>
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<tr>
<td>Lean Manufacturing audits</td>
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<tr>
<td>A.2. WORKERS INVOLVEMENT</td>
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<td>5S implementation</td>
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<td>5S audits</td>
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<tr>
<td>Implementation and monitoring of ideas for improvement</td>
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<td>Study of existing versatility and necessary training</td>
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<td>A.3. COMMUNICATION SYSTEMS</td>
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<tr>
<td>TOP 3 Implementation and monitoring</td>
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<td>TOP 4 Implementation and monitoring</td>
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<td>TOP 5 Implementation and monitoring</td>
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<tr>
<td>3. PRODUCTION QUALITY</td>
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<tr>
<td>Quality implementation and monitoring</td>
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<tr>
<td>4. PRODUCTION EFFICIENCY</td>
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<tr>
<td>OEE measuring and analysing</td>
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<td>ERP implementation and monitoring</td>
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<td>SME methodology implementation and monitoring</td>
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<td>Microsteps implementation and monitoring</td>
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<tr>
<td>TPM implementation and monitoring</td>
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**Figure 2** Breakdown areas to be improved in line E (see online version for colours)
The operation of the line was subjected to a detailed 4-week study in order to determine the cause of the problems, and the lean production philosophy was adopted to define a number of indicators measuring and showing the company’s situation. The indicators selected were: quality, reliability of machinery, visual management, workers’ efficiency, management of stocks, materials flow, human organisation of production, ideas for improvement, worker’s versatility, TOP 5, tidiness and cleaning.

With these indicators, the research group wants to faithfully represent how the line E is working, and what is not being done well, pointing out the main problems, and finally to identify those improvement actions that lead to a better company’s situation. The value of each indicator was obtained using the questionnaires prepared for that purpose, and filled by workers of each shift during the first month of the project.

The results obtained from these indicators are shown in Figure 3, which reveals that problems in line E are, overall, connected with machine reliability, workers’ versatility and internal communication at operator-supervisor level. For this reason, it was decided to implement the lean production techniques presented in the previous section.

Figure 3 Initial situation: indicators (see online version for colours)

Another important point in the initial diagnosis was to identify the reasons for breakdowns and stops in the different machines of line E. Detailed monitoring led to the conclusion that the main reasons were: insufficient cleaning, product changes, workers’ meal breaks, shift changes and start-ups, and batch changes. With the new techniques to be implemented all these incidences are expected to be minimised.

3.2 Improvement project. Objectives

Thanks to the initial diagnosis, the research team raised a series of questions for both the managing team and the work team of line E, dealing with points initially detected as negative, principally in line E:
• Is there any indicator in place, is anything gauged at line level?
• Do you use any of the 7 lean-basic tools (final check, self-control, red containers, re-works, Poka Yoke, first piece OK, QRQC)?
• Is there a benchmark piece/worker hourly yield?
• Does a communication channel exist among the different departments of the organisation and do workers take an active role in it?
• Are there versatile operators?
• Is there any bottleneck? Is it flexible before demand fluctuations?

Non-fulfilment of the previous questions drove the improvement project towards three key elements: training, production organisation and production efficiency, and targets were fixed within each of them (Table 1).

Table 1  Objectives of the continuous improvement project

<table>
<thead>
<tr>
<th>Training</th>
<th>Production organisation</th>
<th>Production efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make operators and mid-level management aware of the importance of lean production methods as a foothold for current market conditions</td>
<td>Optimise the organisation of line E on the basis of the most efficient arrangement possible for each product in question</td>
<td>Realistic appraisal of the capacity of each machine in line E, therefore of the whole line E</td>
</tr>
<tr>
<td>Involve operators in the project</td>
<td>Involve the whole organisation in all actions undertaken, with regard to the tools described above</td>
<td>Improve productivity of machines in question</td>
</tr>
<tr>
<td></td>
<td>Create a communication system to allow decision-making autonomy at operator / supervisor level</td>
<td>Improve format change times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce stocks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve machinery reliability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fix a range of methods and indicators for target setting at company level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make the company adopt lean system and its tools as their own, so they are always applicable</td>
</tr>
</tbody>
</table>

3.3 Improvement actions in the company

As soon as the initial diagnosis of the company was completed, a work plan (Figure 1) was designed to detail the sequence of the implementation and the monitoring of each tool (Hobbs, 2004; Rajadell and Sanchez, 2010), and it was run for 5 months. The whole project was based on the following three key aspects:
Training all personnel in the concepts of lean management and lean production, in particular those related to line E, to strengthen the company’s weak points in certain areas or machines, and to involve the workers.

Organising production by restructuring the current organisation. Through the use of indicators to analyse the improvements needed, the actions taken dealt with a product-oriented optimisation of the organisation of line E, which was performed in the most efficient manner possible. Thanks to the tools chosen, the whole organisation was involved in the actions carried out. A communication system was created to allow autonomous worker–supervisor decision making.

Production efficiency, by means of the implementation of production improvement tools. To do this an OEE Toolkit was used. With this computer software for the automatic collection of information, the reason for the machine stop is entered by the operator manually, and an analysis of the factors necessary for the calculation of the OEE indicator is carried out later. This software provides a view of the efficiency of the machines and equipment. It also reveals potential capacities and shows the shortfall of productivity of every machine.

3.4 Results obtained

After implementing the improvement actions previously described, a lean audit was performed by the research team in order to verify the evolution of the indicators defined in the previous section.

As shown in Table 2, after analysing the performance of line E before and after implementing the lean production system, significant improvements can be seen in all the indicators when compared with the initial situation. The results obtained in cleanliness, human organisation of production, and TOP 5 meetings were especially outstanding.

These results have been obtained fundamentally by the application of the 5S and SMED techniques in conjunction with workers’ training in the above mentioned skills, as well as the establishment of an efficient communication system.

In addition to the improvements shown by these indicators, the company’s overall performance, particularly in line E, has improved thanks to the treatment given to breakdowns, stops and microstops. Given the various proposals made by the research team as well as by the operators, it was observed that by reducing the speed of certain pieces of machinery (grouped, capper) an increase in output could be obtained in these machines and therefore in the whole line. In this case, setting the machines at their nominal speed was not the right thing to do, because most of the machines were intended for glass jars, not for the PET containers used at present.

The improvement in machinery efficiency (OEE) is satisfactory (see Figure 4) since it is a consequence of a 12% reduction of microstops over a 5-month period, thanks to the actions taken by the problem-solving group, who diagnosed that the main problem area was the caps and the capper machine.
### Table 2
Comparison between the initial situation and the improvements performed on line E – radar chart

<table>
<thead>
<tr>
<th>Improvement areas</th>
<th>Before the project (%)</th>
<th>After the project (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>14</td>
<td>52</td>
</tr>
<tr>
<td>Machinery reliability</td>
<td>2</td>
<td>51</td>
</tr>
<tr>
<td>Cleanliness</td>
<td>35</td>
<td>85</td>
</tr>
<tr>
<td>Human organisation of production</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Improvement ideas</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>Versatility</td>
<td>3</td>
<td>68</td>
</tr>
<tr>
<td>TOP5 meetings</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>Visual management</td>
<td>3</td>
<td>63</td>
</tr>
<tr>
<td>Workers efficiency</td>
<td>41</td>
<td>62</td>
</tr>
</tbody>
</table>

![Improvement evolution graph throughout the project](image)

**Figure 4** Improvement evolution graph throughout the project (see online version for colours)
Because of the importance of losses associated with microstops, during the first month of the project these were continually observed and detailed in order to understand the reasons behind them (Figure 5). Consequently, it was decided to carry out a PDCA action plan, where line E workers themselves proposed improvement actions such as:

- creation of specific cleaning methods for each machine
- test different machine speeds to minimise microstops
- analyse the brake system of the Sleever coil, etc.

Depending on the cause of the microstop (raw materials, machine stop, speed loss of the line, etc.) it was decided what action had to be taken, and the person appointed to do it, in order to control and, if possible, eliminate this problem.

**Figure 5** Analysis of the reasons for microstops (see online version for colours)

Shorter product change times also greatly affected the increase of productivity. Since stops were mainly caused by product changes, batch changes, shifts start-ups, missing materials or insufficient cleaning, the application of the SMED method allowed stops to be reduced by 5.5%. Production losses at the beginning of the project due to line stops were 1,429,000 units/month; after applying the SMED method, they were reduced to a more manageable 538,000 units/month. Figure 6 shows an example of the application of SMED to product change times, detailing the incidences occurred.

**Figure 6** Monitoring of the SMED method in different products (see online version for colours)
As shown in Figure 6, the application of SMED allowed a reduction of time in products by defining methods and standardising operations when changing products. The existing differences between the times estimated by SMED and the real times reflect the set of incidences still existing. This drives the Problem-Solving group to carry on designing improvement actions (PDCA) in this type of operations.

Finally, the improved performance of line E, as a result of reducing stop times, breakdowns and microstops in the capper, Sleever and labeller can be seen in Figure 7.

Figure 7  Evolution of losses due to stops in line E (see online version for colours)

In Figure 7, time wasted (minutes per month) has been converted into loss of production (units) to show a progress from 1,632,000 units per month to 747,000 units per month at the time of completion of the project. Losses have decreased by 56% thanks to the application of lean production techniques, and this has resulted in waste reduction, better quality, more controlled costs and more flexibility in the line and the expansion of the company under study. The targets set initially have been accomplished successfully thanks to both workers’ cooperation and management involvement in the continuous improvement project.

4 Conclusions

With the long-term goal to establish a lean management model throughout the whole company, in this first improvement project the company has trained workers and mid-level management in the lean philosophy by applying lean production techniques. Production has been organised to obtain a better optimisation of the resources available, and a communication system has been created to improve production efficiency.

Line E was chosen, a perfect example of the company’s shortcomings, as a consequence of its lack of productivity due, in many cases, to the large number of products with different references that they make.

An important improvement in productivity has been obtained by applying a number of lean production techniques without having to invest heavily, but rather by simply establishing some work methods and training staff in them. To achieve all this, the Management drove the implementation of all the lean techniques. Their commitment has been vital since the start of the project.
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All of this has resulted in more flexibility in the processes of line E, to such an extent that a standardised change of product is now possible, and all customers’ requirements can be met. With a 25% increase in productivity of the line, due to shorter setup times, fewer breakdowns and improved worker performance, its processes have become more efficient and profitable, which translates into the company being more competitive in the market.

Final recommendations made by the research team to the company dealt with the possibility of expanding the lean system to other production areas, without forgetting an ongoing application of the tools developed for line E, in such a way that the lean culture and its work and production methods are gradually being implanted in the company. In this way, errors will be spotted in time and addressed in the most efficient way possible, which will largely avoid costly, time-consuming repairs.

A last point must be made regarding Lean tools. The success of their application will depend on the close cooperation and integration of efforts at all the levels within the company, from the management down to the operators, to reach the goals set.

References


