Lean Application to Food Service in Business

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Abstract

The present study discusses how *Lean* can be applied to catering industry. *Lean* will be introduced along with the case study of a company where these principles and tools were applied. Sources of waste in the meal service were identified, such as the times of the processes that form the service and the operational performance of some employees. The root causes were identified and solutions proposed to mitigate them, along with the estimated impact and their implementation plans. The results show that it is possible to apply and adapt *Lean* to this industry by increasing the level of service and reducing the costs without changing product quality.

Keywords: Lean Manufacturing, VSM, A3 Problem Solving, Food Service, Catering Industry

1 Introduction

Today's catering sector faces numerous challenges resulting from global trends. Global economic challenges, consumer demands, the difficulty of retaining and recruiting employees, among others, create a sustainability problem in the sector where only the most competitive organizations can thrive [1]. In this context, Lean emerges as a way to respond to increasing competitiveness through continuous improvement, by applying a series of methodologies and tools.

1.1 Lean

The term *Lean* originated in the automobile industry of the Japanese company Toyota. This production principle, based on the *Toyota Production System*, was first used by Womack, Jones and Roos in 1990 [2]. Although the automotive industry is characterized as high-volume repetitive manufacturing [3], *Lean* can be successfully adapted and applied to virtually all activities - regardless of whether they are products, services or a combination of both [2] [4].

According to Womack and Jones in 1996, *Lean* is defined as a solution to waste or *muda*. According to Taiichi Ohno, *muda* corresponds to all human actions that consume resources but do not generate *value*. The term *value* is closely linked to the customer's perspective, in the sense of the *added value* that the customer recognizes in a given product or service and by matching their needs [4].

Lean thus emerges to mitigate these wastes by providing a way of specifying *value*, identifying its *value stream*, organizing processes in a productive continuous *flow*, producing only

when needed (*pull*) and striving for *perfection*. These five points define the principles of *Lean* [4]:

1. Specification of the *value* of a product and/or service from the customer's point of view.
2. Evaluate the *value stream* by mapping all operations required to produce a product.
3. Creating *flow*, described as the link between activities that generate value in a continuous productive flow.
4. Allow the customer to *pull* production, producing only when requested by the customer.
5. Striving for *perfection* through continuous improvement.

1.2 Value Stream Mapping

After specifying *value,* a way to evaluate the *value stream* is the *Value Stream Mapping* (*VSM*) diagnostics tool. This refers to the identification and mapping of all processes in a product or product family that has similar characteristics. When applied to services, it is used to gain an overview of current production by identifying all the processes involved. This map aims to characterize operations as activities that generate *value* or not. This characterization in turn allows the continuous improvement process to begin eliminating the activities without *added value* [4] [5].

Using this tool entails a symbology of its own that functions as a standard language to ensure uniformity in the maps, as well as easy understanding by various company employees, regardless of their hierarchy. Nevertheless, Rother recommends the adjustment of this symbology for a better understanding [5].

1.3 A3 Problem Solving

This methodology comes in the scope of *Lean* in order to develop solutions. It was first used by the Toyota company and includes the construction of a document in *A3* format. However, this method, according to the authors, represents more a way of thinking to develop solutions than a written document. *A3 Problem Solving* addition to the title consists of seven different sections, adapted from Sobek and Smalley [6]:

1. *Context* - provide the information necessary to understand the importance of the problem context, aligning the company's objectives.
2. *Current conditions* - simply identify the problem by quantifying the essential parameters to understand the problem from the reader's perspective.
3. *Objective* - describing the objective that will identify the successful implementation of the project. It should include parameters so that it can be quantitatively assessed.
4. *Root cause analysis* - existing root cause analysis tools such as *5Whys* are generally used. The purpose of this section is to expose what the ultimate cause of the conditions described in the second section are.
5. *Countermeasures* - the purpose of this section is to outline solutions that may solve the problem by addressing its root cause.
6. *Implementation plan* - listing the actions required to achieve the objective by naming the people responsible for each action and setting a date of execution.

7. *Follow-up* - it should reflect actions that enable continuous improvement in the future, as well as actions that were not developed during the application of this methodology.

1.4 Methods and time studies

The *methods and time study* is a methodology used to characterize a productive system, developed by Taylor in 1912 [7]. It comprises a qualitative (*methods study*) and quantitative (*time study*) analysis of the processes allowing future evaluation through tools or methodologies such as *VSM* and *A3 Problem Solving*.

The techniques for the *methods study* are essentially visual analysis and personal interaction through informal meetings, allowing the characterization of the processes that make up the productive system, from a qualitative point of view.

As a quantitative analysis, the *time study* can be determined by three principles: estimates, timing history, and in situ time measurements (through instant observations or timings) [8].

1.5 Lean application to the field of study

The catering industry is generally defined by all organizations that are responsible for meals away from home [9]. The sector includes restaurants, catering (canteens in schools, hospitals and businesses), fast food chains, cafes, bakeries, among many others. It is characterized by modern cuisine, being defined mainly by the types of menu and establishment [9].

The application of *Lean* to this industry has been previously described and discussed. A case study of Keyser, Marella and Clay's application of *Lean* principles to restaurants in the United States of America was conducted [10]. This study includes standardizing the table preparation process through a training and visual management manual and applying a production system based on *just in time*. Another case presented by McPherson and Mitchell again demonstrates the application of *Lean* in the context of a restaurant. The principles applied resulted in a 15% decrease in labor costs, a one-third increase in the speed of service, and a 5% increase in sales [11]. Engelund also elaborated a case of *Lean* application in a Danish hospital canteen [12]. This case discusses the application of tools such as *VSM*, *5Whys* and *Kaizen*, in procedures systematization and production reorganization, and enabled an increase in productivity efficiency. At the same time, a customer satisfaction communication system was implemented so that it was possible to continuously meet customer needs regarding meal quality. After extensive research on the main theme of the present work, no literature was found that reflected the application of *Lean* specifically to food service in business or companies.

2 The case study

The present case study company has over 40 years of experience in providing collective catering services in different market segments through subcontracting. This case study focuses on one of its largest clients, where more than 730 thousand meals are served annually. To provide this service, the company has more than 100 employees in this canteen alone. The company's function is to serve meals to customers in a canteen, at three different times: lunch, dinner and supper. It is responsible for

suppliers, storage, ingredient preparation, cooking and meal service. Given the complexity of the characteristics of each phase and to obtain significant results with the application of Lean, with focus being shifted to the meal service during lunch.

3 Methods

To make this study possible, the author conducted a 5-month internship in a catering company. This internship aimed to improve the production process of a canteen by applying *Lean* principles. In the company under study, knowledge of *Lean* principles was practically non-existent. Thus, for this study it was necessary to develop a work methodology to apply *Lean*. The resulting methodology follows three main phases: data collection and processing for processes, information stream, *takt time* and *lead time*; evaluating *value stream* through *VSM* tool; and solution development using *A3 Problem Solving* methodology. For the methodology to make sense according to *Lean* principles, it was previously necessary to choose a product or service, as later defined (meal service).

3.1 Data collection and processing

To use the *VSM* diagnostics tool an extensive data collection and subsquent processing were required. The required data was practically nonexistent not allowing to draw the maps directly. Thus, several steps were created, according to the characteristics of the *VSM*, in order to collect and treat data. For the quantitative and qualitative understanding of the processes that make up the meal service, the author used the *time and methods study* analysis, as well as the analysis of the terminal records (through a software program developed by the author). In order to define the *takt time* and the *lead time*, the customer arrival was accounted, and the waiting lines were timed, respectively.

3.2 Diagnostic

After data collection and processing was completed, the *VSM* maps were carried on following the procedures described by Rother and Shook's literature [5]. Two *VSMs* were drawn for two different food counters. A global *VSM* was also drawn including all food counters (allowing a global view of meal service). Subsequently, the critical aspects of each *VSM* were surveyed.

3.3 Solution development

Entering the last phase and having identified the critical aspects resulting from the application of *VSM*, the study continued to develop solutions using the *A3 Problem Solving* as a methodology. In this methodology the *5Whys* tool was also inserted for the root cause analysis phase. Through the contribution of several employees in meetings, it was possible to find solutions and later outline their implementation, as well as their estimated impact.

4 Results and discussion

This chapter presents the main results and discussions arising from the application of the working methodology.

4.1 Processes

The *methods study* analysis qualitatively characterized the processes which describe the production system of the meal service. From the *value stream* perspective, it was possible to identify the processes that added *value* to the customer's meal - something crucial to identify

in the context of *Lean*. In order to meet the different needs of the customer, the company offers several types of counters (in a total of 7):

- Counters 1 to 4: with a normal menu with four options of dishes between meat, fish, vegetarian, diet and accompaniments.
- Grill counter: several options of grilled ingredients, with the same accompaniment of the normal menu.
- Buffet counter: where the customer himself serves as much as he wants, among various options of dishes.
- Live cooking counter: the customer chooses the ingredients and they are cooked upon request and accompanied by pasta.

The customer in all these counters goes through various processes from *remove the tray*, (choose) *dessert*, *plate*, *registration* among others. The only ones that require employees are the *plate* and *registration* processes, with a total of 19 employees.

The *time study* was made for each counter and process (excluding *plate*) and the cycle times were measured for a total of 560 measurements resulting in a *value-added time* (*VAT*) for all these processes of 50,2 seconds on average. For the *plate* process, the cycle times at each counter and for each employee were also measured, resulting in a VAT ranging from 19,5 to 58,3 seconds. The *plate* cycle time was the longer one from all processes, defining the counter cycle time [7]. A *Matlab* program was also developed to allow the analysis of the counters terminal records. Benefiting from a much larger sample with over 18 thousand records, it was possible to determine the cycle times of each counter: which in turn coincide with the cycle times of the longer process, i.e. the *plate* process of each counter. This result further served to determine the combined cycle time of the *plate* process of counters 2 to 4, having two workstations for this same process. The values obtained through the two analyses were compared obtaining a maximum error of 4,9%. The previous analysis also determined the average number of meals served at each counter, totaling 1897 per day, and that the full service has a capacity of 14,0 meals per minute (by summing the inverse cycle times of each counter).

4.1.1 Complementary Analysis

Based on Chase, Jacobs and Aquilano definition of efficiency [13] two complementary analyses were performed. This allowed further study of the processes that require employees, based on previously collected data. This analysis included estimates for employees' utilization rates in the *registration* process of all counters, and in the *plate* process for counters 2 to 4. For the utilization rate of employees in the *registration* process of this counters, a rate between 27% and 44% was obtained. For the utilization rate of the employees in the *plate* process for counters 2 to 4, a rate between 60% and 68% was found.

4.1.2 Takt time

To assess the pace required by the client [5], i.e. the *takt time*, customers were counted over lunch for 5 days. It can be concluded that *takt time* presents a great variation throughout the meal, and for the critical point between 12:00 and 12:10 were measured 20.2 clients per minute, contrasting with the end of lunch where customers' demand is approximately zero, with a value of 0.1 customers per minute. The *takt*

time for the critical point is then approximately 3 seconds (per meal).

4.1.3 Lead time and inventory

In order to evaluate *lead time*, the time taken by the customer from arrival to departure from the different counters was measured. Assuming that the maximum and minimum *lead time* values occur at the critical point and at the end of lunch, we can obtain these values by directly measuring the times in this time interval. At the critical point and at the end of lunch, the intervals of [476; 641] and [79; 90] seconds were obtained for all counters.

Knowing that *lead time* equals the sum of *value-added time* with *inventory* [5] and knowing the values of both, it is clear that for the critical point the value of *inventory* varies for different counters within [398;558] seconds. *Inventory* translates to accumulation of parts or components before each process (in production units or time) [5]. In the case of a service, this *inventory* can be represented by the time the customer waits before each process and is a waste, as it does not add *value* from the customer's point of view – which in this study will be the only waste considered in the development of *VSM*s. The *value-added time* of the *plate* process from terminal log analysis already naturally includes possible failures that contribute to *inventory* accumulation.

In the remaining processes, no relevant waste has been witnessed and was therefore simplified with the absence of waste in these processes, although they may exist. Thus, the estimated values for the *inventory* represent the waiting times of the customers (queuing times). From the *Lean* perspective, the ratio between *value-added time* and *lead time* should also be evaluated, reflecting the proportion of *value-added time* relative to the total time spent by the customer at the counters. I.e., the higher this ratio, the better the service for the client. These values vary for different counters between 13% and 17%.

4.2 VSMs

As explained in the methodology, on the diagnostic phase it is intended to assess the *value stream* of the meal service and identify the main critical aspects through the *VSM* tool and the previously collected data. The following *VSM* maps were developed:

- *VSM* Counter 1 – aims to understand the tool and possible adaptations needed, as well as the survey of critical aspects. It is known from previous analyses that this is the simplest operating counter, so it was chosen for the first application of the tool.
- *VSM* Counters 2 to 4 - the *VSM* map of counter 3 was prepared, as it has the same typology as counters 2 to 4. Although only one VSM map is presented, all information from the other two counters has been gathered, so that their critical aspects can also be identified.
- *VSM* Full Service - This last map was the result of applying the tool to all counters simultaneously, with the aim of a macro analysis that encompasses all counters. The critical aspects identified in previous *VSM*s were also included on this one, as well as others that will only be identifiable through this macro analysis.

In the case of *VSM*s related to product manufacturing, there is a flow of raw materials from suppliers through the production processes and there is a finished product output [5]. In the present study there is a combination of finished product - meals - and its service. Thus the flow is represented by the customer, unlike in product manufacturing, which goes through all the processes that make up the service until they get their meal, adapting the symbology to better represent the *value stream*. The critical aspects identified in the *VSM*s were as follows:

Inventory - related directly to the queuing times of customers for the different counters as discussed earlier, these are between the values [398; 558] seconds for the lunch critical point. Analysing the different ratios of *value-added time* and *lead time* for the same lunch period, it is estimated that these range from 13 to 17%, representing a small proportion of *value-added time* once compared to the total time the customer spends on the service. Note the main reason for this waste is that the capacity of the service (including all counters) is lower than customer requirements.

Utilization rate of employees in the *plate* process at counters 2 to 4 - this rate indicates a small proportion of useful time spent by these employees, ranging from 60% to 68%, during lunch.

Utilization rate of employees in the *registration* process - reflecting the same problem as the previous critical aspect, these employees have a utilization rate ranging from 27% to 44% for different counters.

In short, it was possible to adapt and apply the *VSM* tool, evaluating the service *value stream* and identifying the main critical aspects or waste to be eliminated later, in the context of *Lean*.

4.3 A3 Problem Solving

Following the methodology present at the beginning of this study, the *A3 Problem Solving* was used to develop solutions of the current critical aspects identified through the diagnosis made by the *VSM*s. Employees responsible for the service, quality management technicians, the production manager, the unit's general manager, among others, were involved in various meetings.

Although the end result of *A3 Problem Solving* is generally a report, typically in *A3* format, the literature indicates that it is much more important to understand and apply the methodology incorporated in this tool [6]. In this context, the respective *A3* report will not be presented as a final result, but rather solution ideas for the previously identified critical aspects estimating their impact and an implementation plan for these ideas.

From the three identified critical aspects, the following problem titles can be obtained in the context of *A3 Problem Solving*:

- Reduction of queuing times (where the aspect related to the utilization rate of the employees in the *plate* process at counters 2 to 4 will be included later);
- Increase employees' utilization rate in the *registration* process.

In the context of *value* definition a new element will be added: this is the *target cost*, which according to *Lean* should be the production cost to be achieved for a product and/or service without waste in the *value stream* [4]. In other

words, in order to reach the *target cost*, the previously identified wastes must be removed, as well as any others that may be identified in the future. Thus, an analysis was made to identify the employees cost (only the ones at the service). For analysis purposes the company provided 4€ per hour for each employee. Considering only four hours of lunch, then an annual cost for the 19 employees of 79 thousand euros per year is obtained.

4.3.1 Reduction of queuing times

To solve both problems, the different sections of the *A3 Problem Solving* described in the introduction were followed.

The goal for reducing queuing times is shown in Figure 1. Through the application of the *5Whys* tool it was possible to address the root cause of the problem, and it was found that the flow of customers at counters 2 to 4 requires them to use mostly the first employee of these counters.

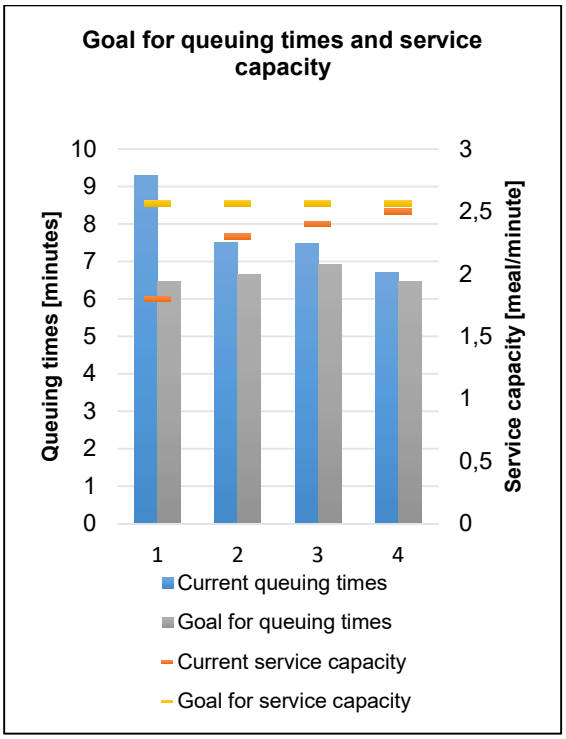

Figure 1 - Goal for queuing times and service capacity

For the generation of solution ideas, it was sought to solve specifically the identified root cause. In other words, countermeasures were developed to increase the utilization rate of the second employees of counters 2 to 4, and consequently to increase the capacity of the service, ultimately reflecting in the reduction of queuing times. Although three solution ideas were generated with the company, only one was selected to develop an implementation plan. Notwithstanding all the ideas generated contributed to make it possible to generate the selected idea.

The selected solution is based on the division of the *plate* process by the employees from counters 1 to 4, where the first employee serves the main ingredient and the second serves the accompaniment. This way it is expected that the employees have a similar utilization rate among themselves, as both are requested in the *plate* process. Consequently it has been estimated to reduce the cycle time of the operation, increasing the service capacity and ultimately reducing the queuing times. A 17% increase of the total service capacity was estimated and a reduction in queuing times ranging from 16% to 61% for counters 1 to 4. On the other hand, the annual cost of the service for employees would increase by 4,2 thousand euros per year, i.e. an approximate 5% increase. This increase in cost may be offset by the resolution of the next problem, as discussed below. It should be noted that this solution does not yet allow to cover customer requirements, i.e. the *takt time* for the lunch critical point. Nevertheless, an increase of 17% of the total service capacity was estimated.

4.3.2 Increase utilization rate in the *registration* process

Following again the same reasoning made for the previous problem through *A3 Problem Solving*, the goal for increasing the employees utilization rate in the registration process is illustrated in Figure 2.

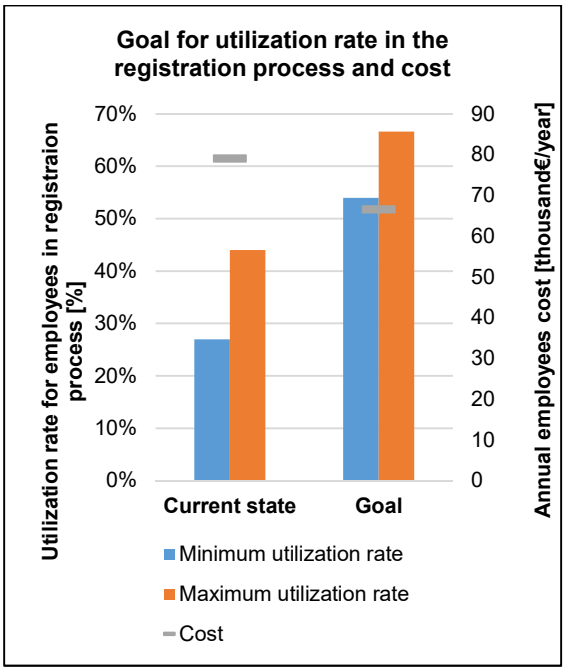

Figure 2 - Utilization rate goal of registration employees

By reusing the *5Whys* it was possible to identify that there is a unique employee in the *registration* process for each counter, which is the root cause of the problem. Three solution ideas were then generated and only one was selected to develop an implementation plan. The selected solution is based on changing the flow of customers in the canteen and rearranging these employees across the different counters (sharing the same employees between counters). It has been estimated that a utilization rate ranging from 60% to 74% can be achieved, as well as a saving of 12,5 thousand euros per year, i.e. a reduction of 16% in the employees cost.

For both problems identified, an implementation plan was developed including concrete actions, employees responsible for these actions and a time forecast for completion of these actions. A follow-up plan was also developed that allows the periodic evaluation of the most relevant parameters of these problems analysed.

5 Conclusions

The collection and processing of data developed was essential to obtain the information needed to produce a diagnosis using the *VSM* tool. As foreseen in the bibliographic review, this tool was adapted changing its symbology to better represent the flow of clients along the processes. The application of *VSM* identified three critical aspects, considered waste to be eliminated from the point of view of *Lean*. To eliminate these wastes *A3 Problem Solving* was used. The main results presented were solution ideas for these wastes by tackling their root cause (coming from the *5Whys* application) and developing implementation plans for these solutions. Maintaining meal quality, the combined estimated impacts of these solutions were as follows:

- Increase in the utilization rate of employees of the *registration* process from [27;44]% to [60;74]%.
- Reduction in the annual cost of employees of the service by 8,3 thousand euros per year, i.e. a reduction of 11% of this cost.
- Increased service capacity from 14.0 meals per minute to 16.4, corresponding to a percentage increase of 17%.
- Reduction of queuing times from 16% to 61% to four counters.

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