Quality Management and the Reduction of Unproductive Times in Agro-Industrial Processes: Bonduelle Portugal

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Abstract

Because of not adding value to the final product, the unproductive times are the subject of this study, in order to proceed, when possible, to its elimination, or the reduction of its duration.

The studies to be developed during this work has as main objective, the creation and implementation of a procedure to reduce the variability, and the duration of unproductive times in production processes, at one food industry factory of a company operating in Portugal.

Moreover, we are also looking to profitably integrate the quality management system already implemented in the company, thereby promoting progress towards a substantial increase in productivity.

First of all, were determined which factors influenced the variability of the unproductive times of the process under study.

After the study, has been found that the use of methods and tools such as 5S, Standardization of Processes (tasks), Visual Control, and the SMED methodology, contributes to the reduction of the variability and/or the duration of unproductive times.

Despite not having been carried out the full integration of the procedure on the quality management system implemented in the company (ISO9001), due to its emphasis on continuous improvement (this being one of the eight basic principles of ISO9001 requirements), it was found that the quality management system already implemented, supports and facilitate the process of reducing the duration of the unproductive times.

Keywords: Unproductive Times, Continuous Improvement, Quality Management, Food Industry, 5S, SMED.

Introduction

The Toyota Production System (TPS), Total Quality Management (TQM) and Total Productive Maintenance (TPM) were developed in Japan as philosophies oriented towards efficient satisfaction of constantly evolving customer needs and expectations. In the US, companies like Motorola and GE developed the concept of Six Sigma (6σ) to pursue similar goals. Quality management systems such as ISO9000 and QS9000 were also developed to guide companies in their conquest of better performance and permanent waste reduction (all that does not add value to products and services) (Pinto, 2006a).

Due to globalization of the economy and markets, companies now face increased competition. There is great pressure to reduce production costs, especially in Western Europe and in the United States, because of increasing opportunities for the relocation of production to more competitive countries (Van Goubergen, 2007).

By not adding value to the final product, unproductive times should be studied, in order to, whenever possible, eliminate or reduce its duration.

This study arises from the need of Bonduelle Portugal continue their loss reduction effort (waste).

In agro – industrial processes using quick freezing as the conservation technology of its products, it is necessary to regularly stop to perform the so-called "thawing" of the equipment carrying out the deep-freezing, the freezing tunnels. The frequency of this stop is related to the equipment being used, and can vary from some hours to some days.

Two other activities where the variation of its duration is also significant are the start and completion of production.

The problem identified is characterized by the existence of a weak optimization in carrying out different tasks during the defrosting activity and/or product change, starting and completion of production, which causes some instability in the planning of production, as well as increases in unproductive times, because when performing these activities the lines are stopped.

The Bonduelle Group was established in the twenties, in France, when Pierre and Benôit Bonduelle decided to begin marketing the vegetables from their family farm in Woestyne. The company thrives and goes into great development after World War II, with registration of the Bonduelle brand in 1947.

In 1989 Bonduelle Portugal was created, and from 1999 onwards the capital of Bonduelle Portugal Agro SA, was fully controlled by Bonduelle SA.

The studies to be undertaken during this work have as main objective the creation and implementation of a procedure to reduce variability and duration of unproductive times in production processes, seeking to integrate advantageously the quality management system already implemented in the company, thereby promoting progress towards a substantial increase in productivity.

Literature review and research questions

The Lead Time and downtimes

According to Pinto (2006a) to start a time reduction process, which is one of the factors contributing to the success of a company, it is important to know the size of each portion of the lead time.

Lead time is the time taken to do something, e.g.: manufacturing lead time, supply lead time or lead time to meet a request from a client.

The main components of lead time, are the following:

- Run: processing time (e.g.: dealing with a customer and manufacturing operations). During this period of time value is added to products or services;

- Unproductive Times: represent all performed activities that do not add value to products or services. Examples: waiting times, setups, transport, breakdowns, delays, quality problems, excess production, etc.

Waste

Unproductive times are considered losses or waste, as they do not bring any benefit to organizations or their production processes.

There are several definitions for loss or waste, and Fernandes (2005) defines loss as the deviation between the ideal situation and the real, deprivation of something, either by loss, destruction, seizure or lack of production, which results, materially, in a loss or decrease in the value of someone's patrimony.

Jackson (1996) *apud* Sebrosa (2008) states that Taiichi Ohno of Toyota defined waste as any activity that does not add value to a product or service. "Value" is what a well informed client is willing to pay for a perfect product delivered at the desired time. As such, anything that, in a process, does not contribute to the creation of a perfect product from the defined date is considered waste.

Amaro and Pinto (2007) describe a number of techniques and tools to identify and classify waste, the three MUs.

In this waste identification approach, the goal is to reach a condition where capacity and what is produced are equal. In other words, there is the amount of labor, materials and equipment to produce the right amount of product/item that has been requested to deliver in a timely manner to the customer.

For the Japanese business management, this is expressed in terms of *muda*, *mura* and *muri*. Three Japanese words that mean (Pinto, 2009):

- *Muda* (waste) – the capacity exceeds what is necessary. All that does not add value is waste and thus should be reduced or eliminated. Seen from another perspective, waste refers to all components of the product and/or service that the customer is not willing to pay for;

- *Mura* (inconsistency or variation) – the capacity sometimes exceeds what is produced, and sometimes is below;

- *Muri* (irrationality) – to produce above capacity. It is eliminated by the standardization of work, ensuring that all follow the same procedure, making processes more predictable, stable and controllable.

Productivity

Many factors affect how people see and define productivity. For example, perception, knowledge and experience, influence how productivity is seen, defined, measured and improved (Smith, 1995).

According to Prokopenko (1992), productivity is the ratio between the output generated by a production system or service and the input used to create such output. Productivity is then defined as the efficient use of resources (e.g.: labor, capital, materials, energy, information), in the production of goods and services.

Greater productivity means more products or services, using the same amount of resources. Usually we have that: Output / Input = Productivity.

Productivity can also be defined as the relationship between the results achieved and the time spent in obtaining them. The shorter the time needed to achieve the desired result, the more productive the system is.

Labor Study

According to Kanawaky (1992), one of the most powerful tools for increased productivity is the labor study.

The labor study consists in systematically examine the methods of implementation of activities in order to improve the efficiency in the use of resources. The major objective of the labor study is to simplify and/or modify the execution method of the different tasks, in order to reduce or eliminate unnecessary work, or the waste in resource usage.

According to Pinto (2009), unnecessary work refers to the movement that is not really necessary to perform the operations. Or it is too slow, or too fast, or too much.

Common causes of unnecessary work are:

a) Isolated operations;
b) Lack of motivation of people;
c) Incorrect work layout;
d) Lack of, or insufficient, education and training of people;
e) Skills and competencies not developed;
f) Instability in operations.

Many of the movements that we do may not be necessary: work is the movement made to create value to the product or service.

The following figures (Figures 1 and 2) show examples of difficult handling and excessive movement.

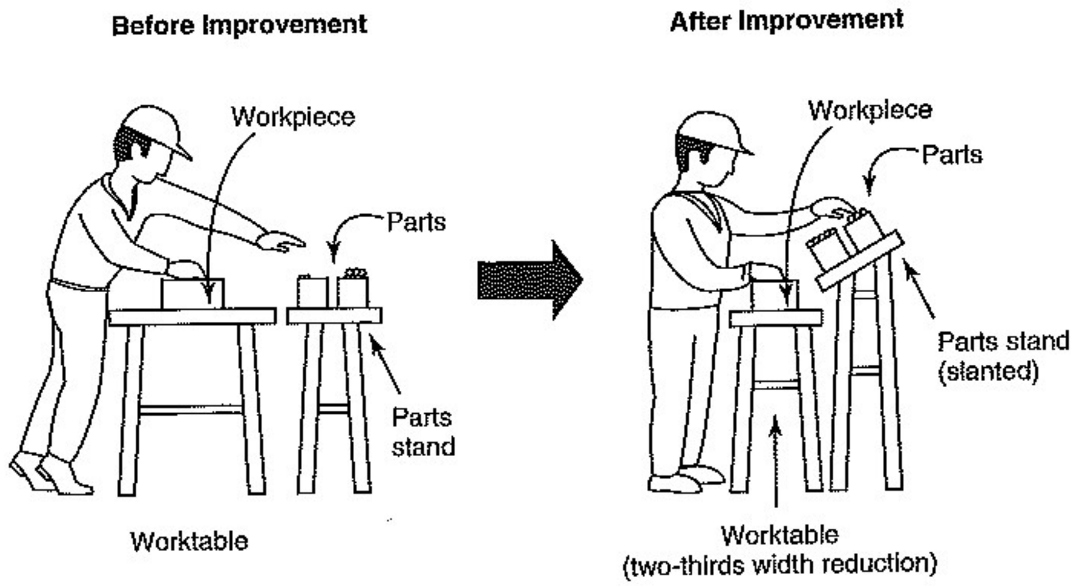

Figure 1: Example of excessive movement and its improvement
Source: TPPDT (1996a), pp. 54

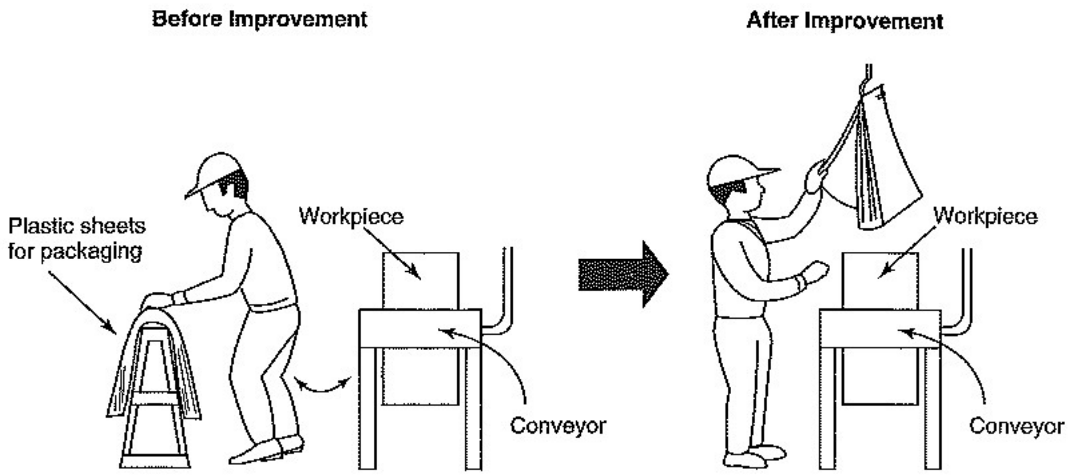

Figure 2: Example of excessive movement and its improvement
Source: TPPDT (1996a), pp. 55

Setup

Van Goubergen and Van Landeghem (2002) and Ulutas (2011) define setup as the time between the production of the final product A and the first good product B, that is, within the standards specified by quality.

In Figure 3 you can see an example of the consequences of a setup in the production of two products.

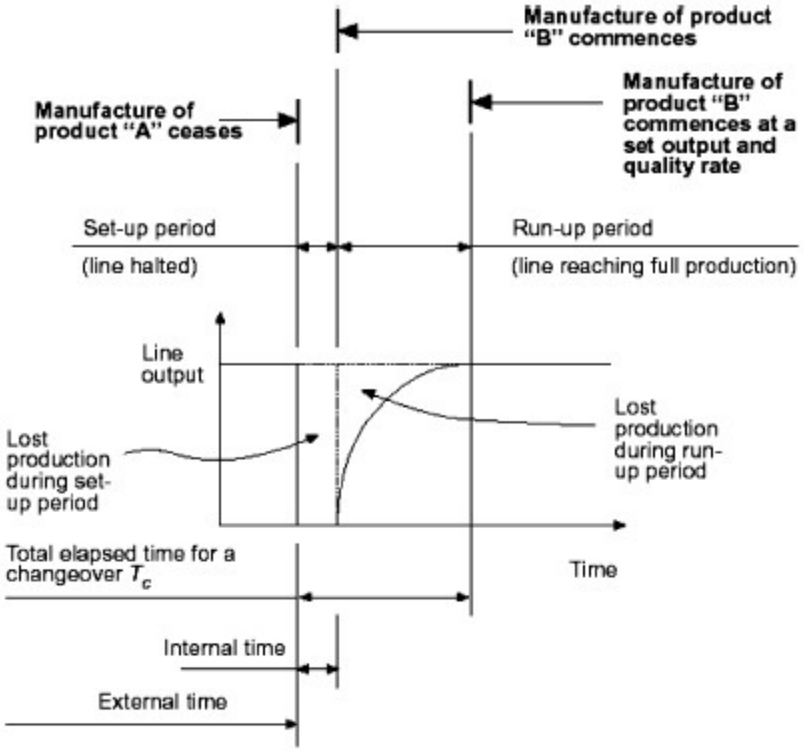

Figure 3: Setup operation period and the obtained output
Source: Cakmakci e Karasu (2007), pp. 335

Michels (2007) emphasizes that, traditionally, companies sought to keep the number of setups at a minimum in order to support production strategies in large batches. The theory was that, in order to justify the setups, the production of large batches was necessary to reduce as much as possible the setup costs. Although the traditional methods minimize the number of setups by producing large batches, this method also contributes to excess stocks, due to the production of a greater amount than what was needed to meet customer orders.

Lopes, Neto and Pinto (2010), report that the diversification of products is growing in current markets, offering greater choice to clients. But a higher number of available goods results in the reduction of the size of orders for the product, and therefore of the setup time, although Jayant, Dhull, Chan and Tang (2007) consider that setup times, in any industry, can be lengthy operations.

Kumar (2013), in turn, presents three reasons for setup reduction:

- Flexibility and inventory reduction: reducing setup time allows the production of small batches, and therefore increases the variety of products available in smaller quantities;

- Production capacity: reducing setup time means increasing production capacity;

- Cost Reduction: part of a product's cost is caused by the cost of production, and production will be stopped less time by reducing the setup time.

Elia (2006) divides the results obtained by reducing setup time into two categories, direct and indirect results:

Direct:

- Reduction in the time of line inactivity;

- Reduction in the time to restore production;

- Reduction of setup errors;

- Product quality improvement;

- Increased workplace safety.

Indirect:

- Inventory reduction;

- Increase in productive flexibility;

- Rationalization of equipment usage.

According to Gathen (2004), the key ingredient for the implementation of a setup time reduction strategy, is total commitment of top management toward the team responsible for this project.

Van Goubergen and Van Landeghem (2002) state that there are several methods of reducing setup times, but that the basic approach and philosophy existent in all of them is the method SMED (Single Minute Exchange of Die). Groote (2006) states that using the SMED method, agribusinesses can reduce the setup time of their lines of packaging until up to 20%. The extra production time obtained can be used, without expensive investments, for higher production volumes and greater flexibility.

SMED Methodology

SMED means Single-Minute Exchange of Die (Tool change in minutes, typically less than 10) and attempts to perform setup operations in short periods of time, i.e., time expressed in less than two digits. The concepts of SMED were introduced by Shigeo Shingo in the 50s in Japan, and from the 80s onwards there was a widespread application of SMED techniques outside Japan's borders (Dave & Filiz, 2012).

In 2001, Moxham and Greatbanks (2001) stated that the SMED method could be applied to any equipment and in any industry.

The SMED methodology takes place in four phases (Dave & Filiz, 2012):

Preliminary phase – Observe and analyze in detail how the setup activities are carried out;

Phase 1 – Remove any unnecessary activity from currently running activities, separate the internal activities from the external ones. Try to perform external activities with the equipment/process running;

Phase 2 – Whenever possible, convert internal activities into external activities;

Phase 3 – Simplify, optimize and rationalize all activities (reduce the duration of the activities, whether internal or external).

In Figure 4 we can see a schematic example of SMED process's steps, noting the large difference in setup time from the beginning to the end of the process.

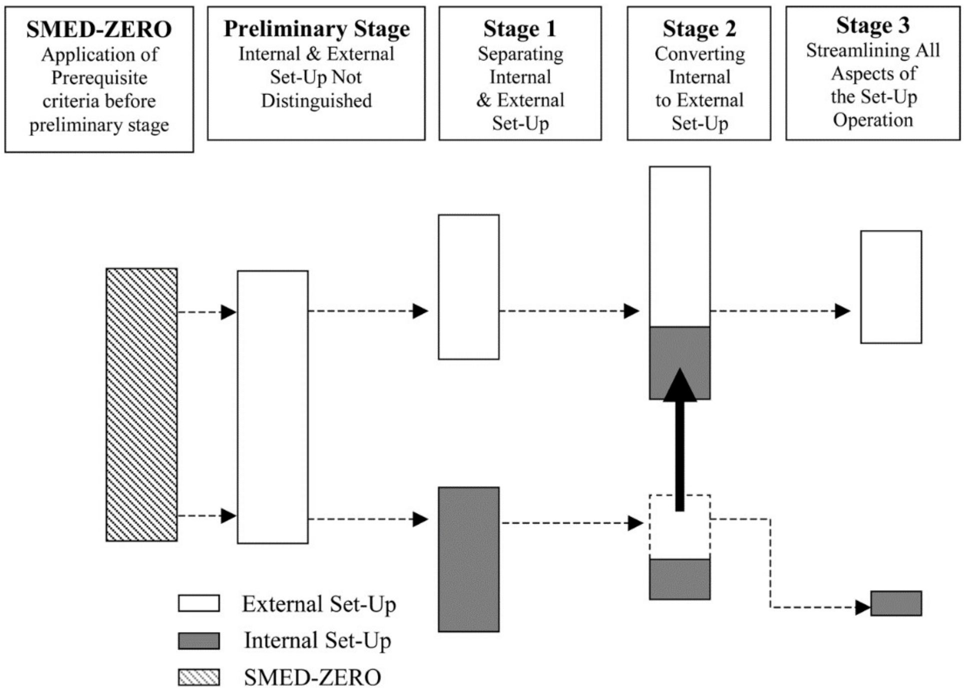

Figure 4: Steps of SMED methodology
Source: TPPDT (1996b), pp. 60

Van Goubergen and Van Landeghem (2001) emphasize that in order to focus initial efforts of setup time reduction it is useful to use a Pareto chart, as shown in the example of Figure 5, which allows to identify which task or set of tasks take more time in the setup process, and the effort of task time reduction should initially focus on these tasks.

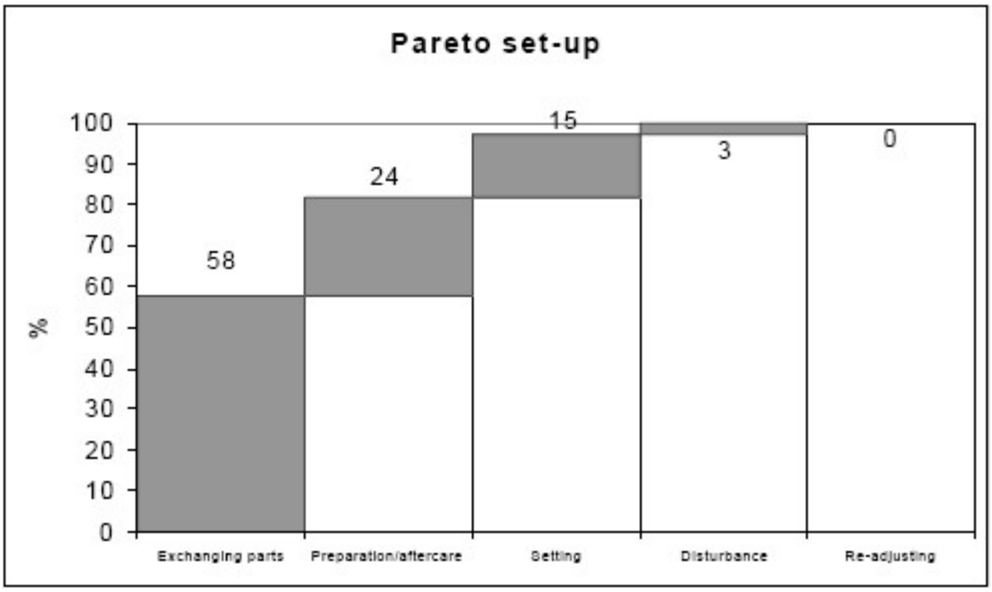

Figure 5: Pareto setup graph
Source: Van Goubergen and Van Landeghem (2001), pp. 6

The SMED method has proven effective for over twenty years, and Trovinger and Bohn (2005) refer to its integration with the modern tools of information technology, giving examples of the use of wireless terminals, bar code and relational databases.

5S Methodology

The 5S methodology is based on five Japanese words, Seiri, Seiton, Seiso, Seiketsu and Shitsuke, that by beginning with the letter S made this methodology known as 5S (Peterson & Smith, 2001; Michalska & Szewieczek, 2007; Foster, 2013).

According to Pinto (2009) the 5S refer to a set of practices that seek to reduce waste and improve the performance of people and processes through a very simple approach that is based on the maintenance of optimal conditions of workplaces (i.e.: ordered, tidy and organized).

The elements of the 5S methodology are (San Miguel, 2010; Heizer & Render, 2011):

• *Seiri* (eliminate): consists in distinguishing between necessary and unnecessary items based on the degree of need, which will determine where the item should be saved or if it should be eliminated, eliminating all unnecessary objects.

• *Seiton* (order): consists in defining the form and identification of storage as well as the quantity and the distance from the point of use. Factors such as frequency of use, size, weight and the cost of the item influence this definition.

• *Seiso* (clean): cleaning means much more than improve the visual aspect of an equipment or environment. It means preserving the functions of the equipment and eliminate risks of accidents or quality loss.

• *Seiketsu* (standardize): standardization of tasks allows maintaining the previous three S (Seiton, Seiso, Seiketsu). This S creates a consistent way so that the tasks and procedures are performed.

• *Shitsuke* (discipline): This concept is based on education and compliance with work rules, particularly concerning organization and security. It is a change of behavior that ensures the maintenance of the remaining S.

The implementation of the 5S is performed in five stages, each stage promoting the application of an element (S). At the end of each phase an analysis of the situation is done in order to verify their correct implementation and subsequent passage to the next stage (Moraes, 2004).

Within the scope of this study, the following research questions have been identified:

• What are the components that influence the variation of unproductive times in the production process under study?

• Will the application of methods and tools such as the 5S and SMED methodology, contribute to the reduction of variability and duration of unproductive times in production processes?

Methodology

Due to the existence of several production processes at Bonduelle Portugal, all of them with a high degree of complexity, only one process was chosen to perform this study.

The choice was the process that is in production during the course of this work, not being revealed by recommendation of the company.

After this work is completed, if the company management team recognizes the procedure created as beneficial, then the procedure can be applied to other processes.

To achieve the defined purpose, the methodology used is as follows:

Bibliographical research and study of several works on implementation techniques/improvement tools.

Information collection and statistical analysis concerning the production carried out to study unproductive times and variations imposed by the several variables, such as:

• Line Manager – verify the existence of differences in the duration of activities between different line managers, and verify that the realization of the whole activity by a single manager is different of the activity be performed by two managers, that is, the person starting the activity it is not the same as the one finishing it, due to shift changes;

• Activity Shifts – verify the existence of differences between the performance of activities in different shifts of eight hours (00-08h, 08-16h, 16-24h);

• Product Sequence – compare duration differences, when a change in product is made, and check for differences between the various product combinations;

• Try to recognize best practices through the use of improvement techniques and tools, and to make changes in the process, in order to standardize the tasks performed, as well as to reduce its duration;

• Creation or change of work instructions to standardize procedures in product changes, as well as in the start and completion of production;

• Information collection and statistical analysis to verify the impact of the changes introduced.

Results analysis and discussion

The content presented below will serve as a guide to reduce unproductive times, and as a basis for the development of training of team leaders as well as of the remaining team elements.

This work is related to the theme of continuous improvement, so this procedure is a cycle, when reaching the end it starts again, as in a culture of continuous improvement there is always something to improve.

Identification of variability factors

In this topic a study of factors that can influence the length of the product change will be presented.

For the process under analysis the following factors have been proposed to the study:

- Shift change: check for variations attributable to the fact that the realization of product change is made by different shifts, that is, the shift that starts the product change is not the same that ends the product change;

- Change of forming tube: in this process, to obtain the final product packaging, the packaging film must go through a tube forming the packaging. Each packed format (e.g.: units of 400g, 750g, 1250g, 5kg...) in combination with each vegetable (e.g.: pea, broccoli, zucchini...), requires a specific tube. There is the possibility that this change results in variations in the time of product change due to the need to change the packaging forming tube;

- Vegetable change: Each vegetable has specific needs of production line cleaning upon completion of production, either by its natural characteristics or by the technological conservation process that has undergone earlier. Therefore, there is a possibility of variation due to product change (reference), with vegetable change;

- Realization Turn: Possible variations due to product change in different shifts of eight hours (00-08h, 08-16h, 16-24h);

Once all information concerning product changes to the process under study was collected, all data was introduced into a statistical software, and after being organized and analyzed, the following conclusions concerning the factors under study were obtained:

- Shift Change: we find that the product change not being started and finished in the same shift, causes a substantial increase in the average duration time of product change. In this case the increase in the average time of the product change due to this factor is between 32% and 108%.

- Forming Tube Change: it is found that the factor forming tube change increases product change time, with an average increase between 49% and 135%.

- Vegetable Change: evidence from the results obtained suggests that this also contributes to the increase in the average duration time of product changes. In this case the average increase is between 43% and 87%.

- Implementation Shift: From the data obtained it is clear that the implementation shift factor influences the duration of unproductive times, by looking to the observed variations. It is worthy of notice that, by the data obtained, it was possible to identify the shift from 00-08h as the shift having values above average, that is, it is expected that in this shift the average duration of a product change is higher than in other shifts.

Enunciation of good practice

Good practices resulting from this example of study of factors that influence the length of product changes time will be enunciated:

- Prevent product changes to coincide with shift changes. To do so, teams should be allowed to continue production until the end of the shift whenever they predict that it is not possible to finish all product change operations in their shift, so that the following shift performs the whole product change.

- In terms of production planning, seek to select the production sequence involving the least possible number of changes in the forming tube;

- As in the case of the forming tube, the number of changes in vegetables must be minimized, by optimizing the planning of the production sequence;

- For the process under study, product planning changes to the shift of 00-08h should be avoided, trying whenever possible to make those changes in the shift of 08-16h;

- Avoid last-minute changes. It is problematic to have a whole line prepared for the production of a given product reference and have to disassemble it all, to make the production of another product that was not originally anticipated.

Application of the 5S Methodology

One of the activities to be developed in order to improve unproductive times is the application of the 5S methodology.

One factor deserving special attention in implementing the 5S methodology is the need to perform activities that are completely different from the normal daily activities of the different actors in the process (e.g.: line managers, operators ...). For this reason it is necessary to pay special attention to compliance with all the rules and safety procedures.

To simplify the audit process all anomalous situations should be recorded. This registration allows an easy transmission of the audit results to the various actors in the process under analysis as well as a proper monitoring of anomalies identified in previous audits. The registration of abnormal situations should always be updated in all audits made to the corresponding area.

The abnormal situation registry map consists in registering the abnormal situation, within the 5S methodology, identifying to which S or S's the identified situation corresponds. Record of the person who identified the situation, so that at the time of resolution any doubt about the planned action can be easily clarified by the person who made the identification. The date and place where the situation was identified is recorded. The action to be taken to solve the situation is recorded, as well as the person responsible for carrying out this action.

It will be good practice not to move to a next S without having all the previous S situations completely solved, naturally with the exception of situations that require a lot of time and/or a high investment.

A practical example of the application of the 5S methodology in a cabinet that supports operations is shown in Figures 6 and 7.

Initial situation (Figure 6):

- Completely messy closet;

- Absence of identifications;

- Presence of unnecessary tools and materials.

Figure 6: Operations support cabinet before 5S
Source: Author

Situation following 5S (Figure 7):

- Improvement in the organization;

- Presence exclusively of necessary tools;

- Correct identification of the location of each tool.

Figure 7: Operations support cabinet after 5S
Source: Author

Application of the SMED Methodology

To reduce the duration and variability of the length of product change time the SMED methodology is required.

This methodology is implemented in four phases, as shown in the following figure (Figure 8), with each phase objectives and application methods described below.

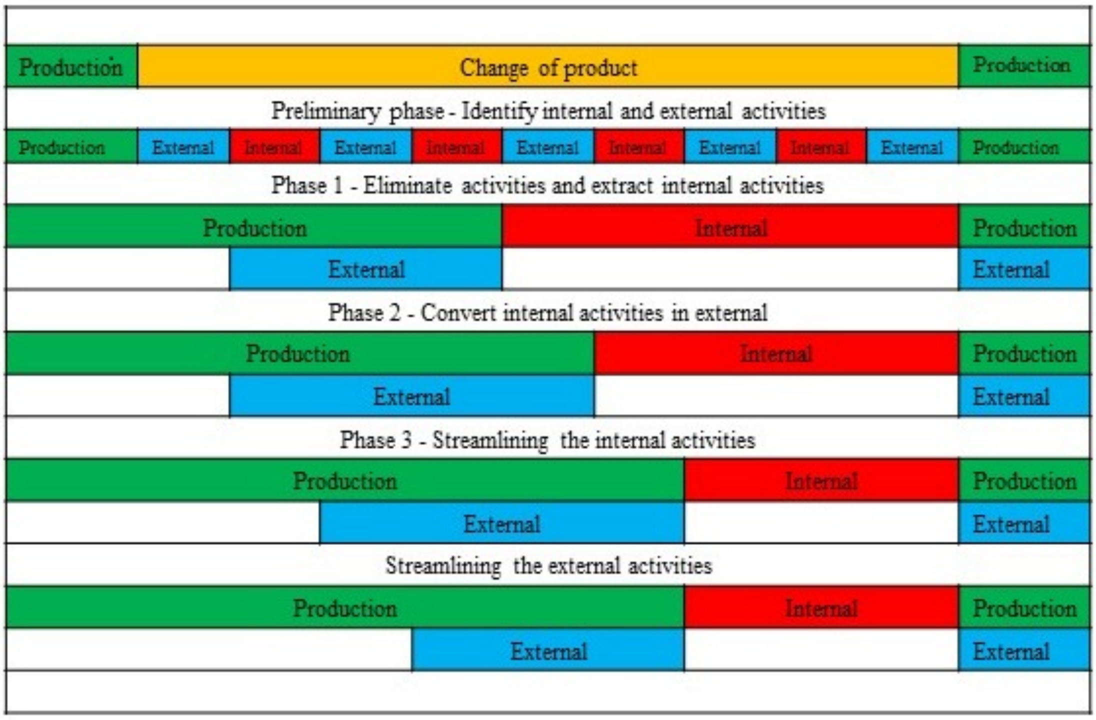

Figure 8 – Phases of the SMED methodology
Source: Author

Preliminary phase

The preliminary phase consists in observing and analyzing in detail how the activities (internal and external) of product changes are made.

- Internal activity is an operation that must be obligatorily performed with the equipment stopped;

- External activities are all activities related to the product change that can (and should) be made with the equipment in operation, either before or after the product change occurs.

The purpose of the preliminary phase is to identify and separate the internal activities from the external activities involved in the product change process.

Phase 1

Goals:

- Eliminate all unnecessary activities, whether internal or external;

- Create checklists for external activities;

- Create a temporary procedure for the remaining activities (internal activities).

Phase 2

Goal:

- Analyze all internal activities and, whenever possible, seek solutions to make them external activities.

Phase 3

Goal:

- Reduce the duration of all activities. In the process of reduction the duration of activities, it should be first reduced the duration of the internal activities, and only after that analyze and reduce the duration of external activities.

Creation of product change matrix

The creation of a product change matrix is extremely useful in terms of production planning, as it allows a simple way to choose the sequence of products in order to reduce overall processing time.

Note that it is important to analyze a product change in both directions, that is, analyze the change from product A to product B, and the change from product B to product A, because they may have significant differences in duration.

This difference is due to the characteristics of each product: for example, if product A is pre-fried and product B is blanched, the change from A to B will always be longer than changing from B to A, because cleaning a line in which a pre-fried product was packed is much more complex than cleaning a blanched product.

Figure 9 exemplifies a product change matrix. In this case the duration of the product change times were grouped into three major groups, long duration, medium duration, and short duration changes.

		Initial product						
		Vegetable A 1,0 kg bleached	Vegetable B 5,0 kg pre fried	Vegetable B 1,0 kg bleached	Vegetable A 400 gr bleached	Vegetable C 1,25 kg bleached	Vegetables A + B 1,0 kg bleached	Vegetable C 2,50 kg bleached
Next Product	Vegetable A 1,0 kg bleached		G	S	M	M	S	G
	Vegetable B 5,0 kg pre fried	M		S	G	S	S	G
	Vegetable B 1,0 kg bleached	M	S		M	G	M	S
	Vegetable A 400 gr bleached	S	G	S		M	G	S
	Vegetable C 1,25 kg bleached	M	S	M	S		S	M
	Vegetables A+B 1,0 kg bleached	S	G	G	M	S		S
	Vegetable C 2,50 kg bleached	M	S	M	S	G	S	

Figure 9: Change of product matrix
Source: Author

Note - Extent of the change: G – Great; M – Medium; S – Short.

Figure 10 shows a practical example of the application of the product change matrix. In this case the initial planning involved seven product changes, four of these changes were long duration, one was a medium duration and two were short duration changes.

After reformulating the initial planning, taking into account the information in the matrix, it was possible to reduce the number of product changes to five, all of them being short duration changes.

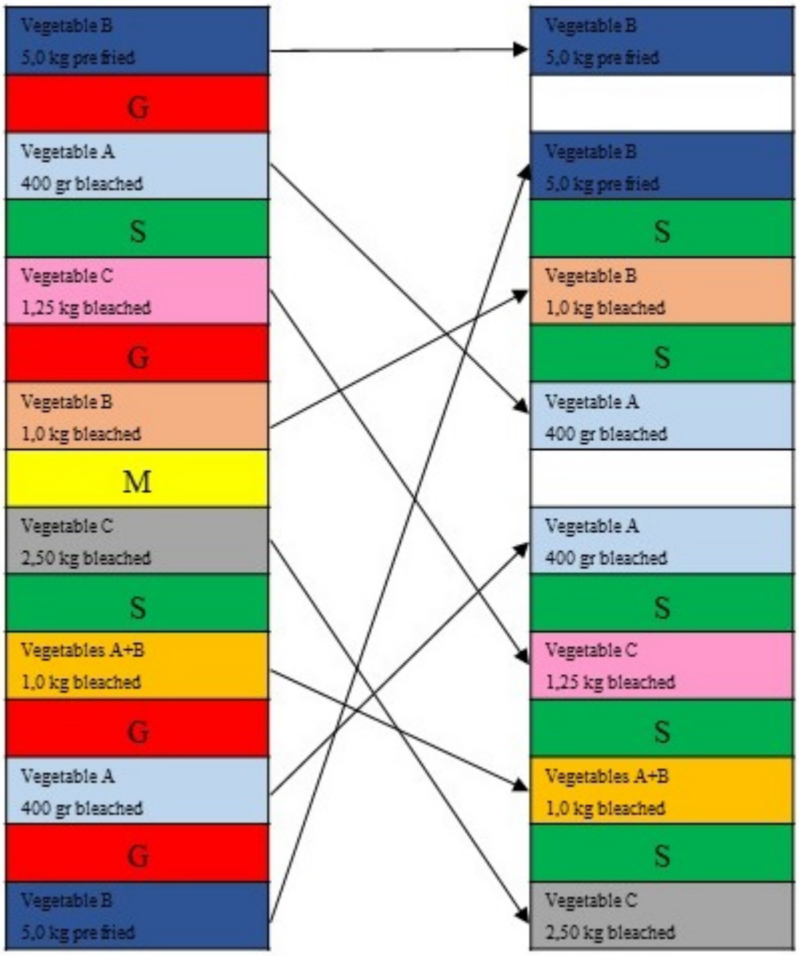

Figure 10: Change of product matrix example
Source: Author

This reformulation of the planning allowed a considerable improvement in production, reducing product changes from seven to five, all five of them being short duration changes.

Conclusions and recommendations

Based on the previous chapter we can say that the objective of this study was achieved because at the level of the research questions, either by the practical work performed, or by the literature review, we obtained favorable conclusions, which will be presented below.

Looking to the good practices identified, it can be said that the result presented is positive, as it serves the purpose of continued loss (waste) reduction effort by Bonduelle Portugal.

In what concerns the first research question, we conclude that the factors that influence the variation of unproductive times are:

- Shift Change;

- Forming Tube Change;

- Vegetable Change;

- Implementation Shift.

In what concerns the second research question, we can conclude that the continuous improvement methods and tools used facilitate the reduction of variability and duration of unproductive times.

It can also be concluded that the 5S method is more influential in the reduction of work duration, and that the SMED methodology influences either the reduction of work duration, or the reduction of the variability of unproductive times.

As main recommendations for future research we can highlight the continued application of the procedures in the area under study, and the extension to other areas of the plant where its effect will be even more visible, and also the study of other continuous improvement techniques and tools that can be integrated in the procedure presented aiming the optimization of the entire production process.

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