Enterprise Management through Kaizen-Lean methodologies
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Abstract
The implementation of Kaizen methodology is increasing in several companies. The Kaizen methodology uses several Lean tools to reduce production and structural costs and to achieve the continuous improvement by reducing waste activities. Iberol, leader of the Portuguese biodiesel production market, needed to improve its processes and change the culture rooted in the company in order to better adapt to the new challenges.

The implementation of Daily Kaizen in Iberol was very useful for the organization of the daily work by creating regular team meetings and cleaning and organizing the workplace through the implementation of 5S's. Based on the Total Productive Maintenance approach, the Autonomous Maintenance and the Planned Maintenance were implemented to reduce maintenance costs. Other important Lean tool is the SMED (single-minute-exchange-of-die), this tool was implemented in the Iberol's seed exchange process by mapping the whole process, detailing the internal and external tasks, normalizing procedures and finding improvement opportunities to a final aim of reduce the setup time.

To gather all the important information and to create a historical data of the key performance indicators used in each Daily Kaizen, an Excel-based framework was created, named KaiDi, which could be used in the company's sustainability assessment.

Keywords: Kaizen, Lean, continuous improvement, process improvement

1. Introduction
The economic, cultural, political and financial globalization significantly enhanced the company business opportunities and the level of competition faced by companies. So, they tried to reduce their structural and production costs through continuous process improvement and waste reduction by using management tools [Mesquita et al, 2003 e Mrak, 2000]. This approach was particularly important in the last ten years due to the general crisis that affected a great part of the developed countries [IFR]. The Kaizen Method has been distinguished as a good method for processes improvement because its implementation costs are minimal [Boca 2011; Black, 1999]. This method aims to improve continually and incrementally all aspects of a process/organization through the extensive involvement of all employees in the company [Imai, 1986; Thessaloniki, 2006] and having as driver the Quality, Cost, Delivery (delivery services) and Motivation (QCDM) model. Kaizen created this model to improve QCDM in the company and by eliminating waste (Muda in Japanese) and improving documentation processes. This leads to a sustained growth of earnings and sales [Kaizen; Imai, 1997]. The reduction of waste can be carried out using Lean concepts and tools such as Single Minute Exchange of Die
This paper describes the implementation of Kaizen-Lean methodologies at Iberol, the Portuguese leader of biodiesel production. Iberol intends to optimize its processes and make a deep cultural change in its workforce. Kaizen implementation is a long-run process with no end data because improvement is a never-ending process.

In Section 2 of this paper, it’ll be presented the Kaizen-Lean methodology. In Section 3 the case study will be presented, Section 4, the implementation of the methodology Kaizen-Lean in Iberol will be described and the conclusions reached in Section 5.

2. Kaizen-Lean methodology

2.1 Kaizen

Kaizen is a Japanese word that means continuous improvement. The Kaizen methodology was developed after the 2nd World War during the Japanese economic crisis. At that time, it was created, in the USA, Productive Centers to form Japanese engineers in the best practices at American industries [KHistory]. The knowledge acquired combined with the oriental culture lead to a new methodology named Kaizen. Thirty years later, in the seventies, the oil crisis change radically the international market and the western companies revealed difficulties to adapt to this new reality, in contrast to the Japanese companies that practice Kaizen methodology. So, Western decided to implement the Kaizen methodology in theirs facilities [Kaizen].

This methodology of continuous improvement is based on three key points: Everybody, Every day and Everywhere [Imai, 1986] and begins with the admission that every organization has problems. This provides opportunities of improving Quality, Control, Delivery and Motivation (QDCM model) [Kaizen]. The improvement process follows next five steps: 1- Define Costumer Value, 2- Define Targets and Kaizen Teams, 3- Work on Gemba (the place where value is created), 4- Search for the three types of waste: Muda (activities that are wasteful), Mura (inconsistency of stocks) and Muri (overburden of procedures) [Typeswaste]. These ones are the main causes of productivity losses, and 5- Kaizen implementation.

In order to achieve a successful implementation, the Kaizen methodology follows the Kaizen Management System (KMS). The KMS focus on: Mission – clarify the strategic objectives of the company, Initiatives – includes five initiatives: Total Flow Management (TFM) that covers all the information/material flow activities [Synchrono, 2013], Total Productive Maintenance (TPM) that searches for the productive excellence [TPMa], Total Quality Management (TQM) that focus on the improvement of quality at all levels [Holmes, 1993], Total Service Maintenance (TSM), which is the TPM applied to services [TSMa] and Innovation and Development Management (IDM) that supports the development of new projects [Kaizen], Organization and Implementation of Kaizen – manages the change/transition from an old culture to the new one, Principles and Values – includes Kaizen thinking and the elimination of waste (Muda). Muda can be generated by people, resources or machines [Thessanoliki, 2006] and are associated to: over production,
inventory, defects, motion, over processing, waiting and transportation [Melton, 2005]. The Plan-Do-Check-Act (PDCA) is a four step cycle that many organizations used to guide their improvement efforts. Plan: identify the problem and plan a change/test. Do: Apply the change/test. Check: analyzed the results. Act: Implement and standardize the procedures that had success [PDCA].

2.2 Lean

Lean is a socio-technological system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer and internal variability [Shah & Ward, 2007]. The Lean methodology focuses on eight key-points: Purpose, Process, People, Pull, Pull-Based, Prevention, Partnering, Planet, Perfection [Hines, 2010]. Melton (2005) states that the implementation of Lean methodology involves five steps: 1) Collect data: Observe the current processes and search for non-added value activities or waste activities. Involve the people who run these processes taking advantage of their knowledge, 2) Analyze Data: Start to diagnose the issues through data analysis and look for undesirable effects. 3) Design the change: Based on the data analysis, design the change using the actual or a new process having as objective the elimination of waste, 4) Make the change: The process is put in place with appropriate training and measures. The team has the ability, if necessary, to monitor the sustainability of the change and make adjustments 5) Measure benefits: The new process is monitored and the benefits evaluated on an ongoing basis. If necessary, further improvements can be made [Melton, 2005].

The Lean methodology uses different tools to identify wastes and improve processes:

- **Value Stream Mapping (VSM)** – The VSM tool, developed at Toyota, maps in high detail the flow of material and information of a process [Irani & Zhou 2008]. A VSM involves: Define the Value for the costumer, Map the initial state of the process, Analyze the data and create improvement proposals, Map future state of the process and Make an action plan.

- **5S’s** - The fives's was developed by Lean, in Toyota, with the main objective of creating a clean and organized workplace [5Sa]. The five S’s refer to five Japanese words that represent five different activities: **Seiri** (Sort) – Sort the objects and keep only the ones that are essentials in the work place, **Seiton** (Set in order) – Organize the workplace, **Seiso** (Shine) – Keep clean the workplace, **Seiketsu** (Standardize) – Standardization of processes and maintain the three previous steps and **Shitsuke** (Sustain) – Keep all the standards in order [Fargher, 2006, Manea, 2013].

- **SMED** - Single Minute Exchange of Die (SMED) is a system for reducing the time in manufacturing processes. The SMED implementation follows the following steps: 1) Observe the current methodology: the process must be filmed for an exhaustive analysis, 2) Separate internal from external activities; 3) Convert internal activities in external activities; 4) Line up the Setup; 5) Continuous training: after the first successful application of SMED, the employees should be trained in the new procedures [Dave 2012, SmedA, SmedB].
• Route Cause Analysis - Root Cause Analysis investigate and categorize the causes of the problems that helps to identify why an event occurred. It is also applied to evaluate processes and risk management [Rooney, 2004]. This tool uses the Five Whys technique, i.e. the cause of the problems is questioned five times, which helps the identification of the true cause. [Sondalini, 2011].

2.3 Comparative analysis of others methodologies
The Kaizen-Lean methodology is compared with Six Sigma and Business Process Reengineering.

2.3.1 Six Sigma
Six Sigma is a management-oriented approach to improve products, services and processes through a continuous reduction of defects by using advanced statistical tools [Kwak and Anbari, 2004; Antony 2004, Urdhwareshe, 2000]. The implementation of the Six Sigma has as objective to attain a maximum of 3.4 defects per million of processes, products or services, or achieve a success rate of 99.9997% [Kwak and Anbari, 2004; Thornton].

Six Sigma and Kaizen-Lean is the fact that Six Sigma uses a statistical analysis to quantify the defects in the processes and Kaizen-Lean makes many incremental or small-step improvements in the whole process over time [Lean&SixSigma, ABI].

2.3.2 Business Process Reengineering
According to Bogdaniu, the Business Process Reengineering (BPR) helps the companies to rethink the way that certain work was performed in order to improve customer service and to reduce operational costs. The BPR reformulates the processes through its Redesign, Retooling and Re-orchestrating [Fitzgerald and Murphy, 1996; Hammer and [Hammer e Champy]. This method involves major improvements and structural changes in terms technological, organizational and human [Zigiaris, 2000].

A BPR project has a start and an end date, while the Kaizen methodology has no end date since its philosophy based on continuous improvement, which means is a never-ending effort to identify and eliminate root causes of problems [Bogdaniou; Gebrehiwot, 2010]. Changes in the processes, resulting from the implementation of BPR, are usually abrupt because are usually associated with the use of new technologies or equipment. The use of Kaizen methodology introduces only slow, continuous and incremental changes in the process because they are supported by common sense [Gebrehiwot, 2010].

Six Sigma and BPR methods involve a drastic change of procedures but do not act directly on a socio-cultural change at the company.

3 Case study of Kaizen-Lean methodology in Iberol
This paper addresses a real case study of a Portuguese manufactory company, Iberol. The implementation of the Kaizen-Lean methodology in Iberol, aims to improve and restructure all the processes and, simultaneously, to make a cultural change in its workforce, in order to reduce costs and reorganize work and flow of information.

Iberol produces biodiesel and flour from soy bean and rapeseed. The first step of the process involves the Preparation of the seeds. In this step, the seeds are crushed,
cooked and laminated. The rape seeds, which contain 40-50% of oil, are pressed to a partial oil removal. Next, soy bean and rape seed are expanded and then contacted with hexane. The solid phase (bagasse), after hexane removal, is transformed in flour and sold to be incorporated in animal feed. The liquid phase, a mixture of oil and hexane, is separated by distillation. Hexane is recycled to the process and the oil is sent for biodiesel production unit.

In this unit, the oil is subject to a chemical neutralization. The reaction of transesterification involving oil and methanol produces biodiesel and glycerin, a by-product.

The previous mapping of all company activity (VSM) carried out in 2014 by Kaizen Institute has identified some opportunities for improvement in operational and administrative areas.

3.1 A3
The “A3” was the first tool to be implemented. The “A3” is a sheet with nine fields that resumes the relevant information of the project and facilitates its analysis. The A3 was used in all new projects of continuous improvement. It worth noting that this sheet is usually accessible to all employees breaking the idea that some information is only available to few.

3.2 Daily Kaizen
The Daily Kaizen is a fundamental step in Kaizen methodology and includes four levels. The first level organizes the team and establish standardize team meetings. The second level cleans and organizes the workspace. The third level standardizes procedures and finally the fourth level improves the standard procedures.

Iberol implemented the first level of Daily Kaizen in all operational and administrative areas. It was build a team board (Fig. 1), which includes the performance indicators (green area), the team’s plan (red area), the action plan (red area), the outcome of the audit agenda (yellow area) and facultative fields (blue area).

Figure 1 - Board of Daily Kaizen
The performance indicators must be easily obtained, simple, stable and measurable in order to be easily analyzed and to represent the team’s work. The team’s plan is a daily plan that organizes the work. The action plan allows monitoring the improvement actions through PDCA (Plan-Do-Check-Act).

During the implementation of Daily Kaizen level 1 it was noted some difficulties in defining performance indicators, collecting data and creating a routine for the team meeting. This meeting allowed to organize the scattered information and increased the effectiveness of response of the operators to sudden changes of the process or even breakdowns. The implementation of Daily Kaizen level 1 increased the worker’s motivation since they felt part of the change process in Iberol.
The second level of Daily Kaizen organizes the workspace by using the 5S tool. This level of Daily Kaizen was implemented only in one area in Iberol. This action lasted one month and created a healthy, pleasant and organized workplace, which increased the security and motivation of workers. An example of the implementation of the 5S is presented in Fig. 2.

3.3 Total Productive Maintenance
TPM is a methodology that seeks for productive excellence. This methodology is used in companies with continuous production processes like Iberol. In order to achieve the excellence it is necessary to implement Autonomous Maintenance and Planned Maintenance.

The Autonomous Maintenance (AM) involves the implementation of equipment maintenance routines. AM was not the result of a desire to reduce maintenance costs or maintenance departments wishing to hand tasks over to production, rather it was the result of production teams wishing to control and improve their equipment [Jones, 2014].

The implementation of the AM has five steps. The 1st step restores the initial conditions of the equipment, the 2nd eliminates the contamination sources and improves the accesses to the equipment, the 3rd defines cleaning, inspection and intervention actions (Fig.3), the 4th coach the workers in AM and finally the 5th carried out the AM [Kaizen].

The Planned Maintenance (PM) is a TPM tool that schedule maintenance routines to reach zero breakdowns [Kaizen]. The implementation of PM began with the elaboration of a risk matrix that evaluated and ranked, 781 equipments, on impact, probability of occurrence and detection of failure. It were selected 43 equipments that presented the higher risks and were created detailed plans of PM. These plans include the human resources, the duration of each task and the points of maintenance.

Like AM the PM is also in the beginning of its implementation so it’s not possible to quantify its results.

3.4 SMED
Iberol implemented SMED in the process of seed exchange (setup). The seed exchange begins with the stoppage of the whole process (Preparation and Extraction), follows the exchange of expander and the start of the process (Preparation and Extraction).
As described in the section 2.2, the SMED has five steps. The 1st step (observation of the current process) was divided in two parts. The 1st part consisted of the observation of the stoppage of the process and the exchange of the expander. The 2nd part begins when the new seed is fed to the expander. All process was video recorded. It was registered the duration and frequency of each task in this process and also the tools used. The analysis to the overall process leads us to conclude that there are few external tasks, i.e. tasks that can be performed when the expander is in operation.

In the 2nd step it was listed and analyzed all the tasks/activities with the objective of separating the external tasks from internal ones. The internal tasks only can be performed when the expander is stopped. The external activities are few and because of this the modifications suggest did not change significantly the overall process. An example of an external activity is the preparation of the tools for the exchange of the expander. It was decided that these activities must be carried out at the beginning of the changeover with the expander in operation. The data collected were compiled in a Gantt chart that helped the analysis of the whole process.

It was proposed to carry out a meeting two days before the change of seeds with all the players in the setup. This meeting will allow to plan, organize and communicate details and major tasks that will be performed in the setup. This prevents misunderstanding due to the lack of communication between the different areas. It was also decided to create a standard procedure for the exchange of the expander in order to reduce the variability of the process.

It was also suggested and later on tested, with success, the reduction of time for removing the old seed from the extractor in 25%.

The 3rd, 4th and 5th steps weren’t followed due to the fact that the implementation of SMED in Iberol was in an early state.

3.5 Key Performance Indicators (KPI’s) – Daily Kaizen (DK)

An important part of theis to follow and to analyze the KPI’s of each area. Because Iberol does not have a data base of the KPI’s it was created an Excel file, named KaiDi, to calculate KPI using process data. It includes results of eleven areas and fifty-two KPIs. This file eased the analysis of the evolution of each KPI and will become a very important tool when it comes to evaluate the work that’s been done in each area.

4 Future work

As future work, it is suggested to create of summary file in Excel containing the most relevant KPI of each area as a Global Metric Evaluation (GME) for the company. The GME file should be included in monthly and annual Iberol reports of sustainability accessible to administrators.

The KPI’s present in the GME file was decided by the responsible of each area. These KPI in this sheet can be easily changed because this file is built in a system called dynamic graphics that offers the chance to choose what KPI is displayed.
As mentioned, the GME file is automatically updated when the data is introduced in the KPI file (Fig. 4). In the case of daily indicators, the chart will include the respective month and will be renewed on 30th or 31st day of each month. For weekly indicators, the corresponding chart will include the four weeks of the month and will be renewed after the fourth week.

After the preparation of the monthly GME file it should be created an annually GME file that is created based on the average of the monthly values.

The GME file will centralize all information and will simplify the analysis of important indicators by the administration. This will be an important asset in future studies/analysis and can also be used as a base for studies of improvement of processes, taking into account the entire history created.

5 Conclusions

Kaizen-Lean methodologies were implemented at Iberol to make cultural changes, improve the organization of workspaces, the extended setup times and the maintenance procedures.

In order to solve those issues were addressed several activities that used Lean tools to study, analyze and improve the processes.

After detailed analyses of all processes in Iberol it was decided to implement the daily Kaizen in eleven areas. The Daily Kaizen include the creation of a standard meeting and the implementation of the 5S’s tool, followed by the implementation of maintenance procedures, like Autonomous and Planned Maintenance and finally the implementation of SMED. The use of 5S’s tool allowed to clean and organize the workplace and to find some tools that have been lost. The Autonomous and Planned Maintenance lead to the reparation of small of equipment’s defects for restoring its initial conditions. It was also defined new plan of the equipment’s maintenance that will allow to reduce its costs. The SMED was applied to the change of the expander and it was possible to reduce the time of exchange in 25%.

It was created an excel file to calculate all the KPIs of each Daily Kaizen. This file will be fundamental to an easier analysis of the processes and to create historical data. The introduction of the Kaizen methodology in Iberol changed the way workers face daily work, since day one, they’ve been more motivated to face new challenges that come with new procedures. The fact that everyone is involved in the change process provides a healthier work environment in the company.
References

5Sa: https://www.ipfw.edu/dotAsset/17b930d9-ca78-4b4b-94e3-f10265bcc3bc.pdf (consultado em 16/05/15).


Fargher, J. S. W. Jr. (2006) Lean Manufacturing and Remanufacturing implementation tools, Missouri Enterprise, University of Missouri, Rolla, MO


Kaizen: Introdução ao Kaizen, Kaizen Institute.http://repositorio.toolingportugal.com/Apresentaes/Eventos/%28I%29%20%20%29%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20%20...
KHistory:
http://www.buzzle.com/articles/history-of-kaizen.html (consultado em 16/05/15).


Lean&SixSigma:
http://leanblitzconsulting.com/2013/01/what-is-lean-six-sigma-kaizen/ (consultado em 16/05/15).


PDCA: Plan-do-check-act (PDCA) cycle


SmedA:
http://www.leanproduction.com/smed.html (consultado em 16/05/15).


TSMa: http://sg.kaizen.com/fileadmin/DATA/kaizen_sg/Documents/Flyer/Flyer_TSM_Aug12.pdf (consultado em 16/05/15)

Typeswaste: https://bobsleanlearning.wordpress.com/2010/01/14/muda/ (consultado em 20/09/2015)
