Leverage of a Management System by *Kaizen*-Lean Methodology

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Abstract

The *Kaizen*-Lean methodology implementation is not always an easy transition, and many companies face difficulties when implementing a new work methodology. This thesis enabled the leverage of this methodology at IBEROL - Sociedade Ibérica de Biocombustíveis e Oleaginosas, SA, started in the end of 2014. The constraints faced were: poor subproject steering, low *Kaizen* auditing results, incomplete implementation of Daily *Kaizen* Level 1, slow implementation of Level 2, Autonomous Maintenance was discontinued, lack of data and monitoring of activities, high discontent of employees towards the methodology, and weak *Kaizen* culture. To contradict this tendency several measures were adopted in the company, such as stronger subproject steering with weekly and standardised meetings and action plan monitoring, spreading of Daily *Kaizen* Levels 1 and 2 implementation, practice of *Kamishibai* and *Gemba Walk* audits, creation of Autonomous Maintenance audits and KPI's, development of continuous improvement training lessons, and establishment of Microsoft Excel support tools for KPI's monitoring. In addition, a rewarding system was outlined to improve employees motivation based on their *Kaizen* participation, and the *Kaizen* practices compatible with ISO 9001 were identified.

Keywords: continuous improvement, 5'S, *Kamishibai*, rapeseed, soybean

1. Introduction

IBEROL - Sociedade Ibérica de Biocombustíveis e Oleaginosas SA. was established in 1967 in Alhandra, in the municipality of Vila Franca de Xira, Portugal. At present time, this company has a business volume of 160 million Euro, and directs its principal activities to the biodiesel production [1]. The company also extracts raw oil, as feedstock for the Biodiesel Production Unit (BPU), in the Preparation and Extraction Unit (PEU). In the latter, rapeseed oil and soybean oil are extracted and the correspondent meals are produced [1].

According to its Quality Policy, the company compromises itself in satisfying the clients needs by providing products within their expectations, and assuring their loyalty. To achieve the continuous improvement of the processes and involving the employees in quality principles, IBEROL decided to implement the *Kaizen*-Lean methodology in the end of 2014, but by September of 2015 the efforts made to implement this new work methodology decreased, due to low employees motivation, wrong implementation approach or even due to difficulty in identifying waste and measuring results.

This work intends to leverage the *Kaizen*-Lean implementation at IBEROL by identifying its constraints and solving its gaps, developing support tools, standardizing procedures and stimulating employees' *Kaizen* culture. The Microsoft Excel tools developed were assisted by VBA code to facilitate the user's utilization.

2. Background

Kaizen is a Japanese term that means "change" ("kai") and "better" ("zen"), representing the concept of continuous improvement. This philosophy was born in Japan right after the Second World War, when this country was economically vulnerable. The Japanese managers and co-workers realised their companies survival was dependent on an uninterrupted and daily progress, with small and incremental changes in their standard work. However, the term "Kaizen" was created by Masaaki Imai while working at Japan Productivity Center, in Washington D.C., in the 1950's [2]. Later on, in 1985, Masaaki Imai founded the KAIZEN Intitute, that developed the *Kaizen* Management System (KMS) and the *Kaizen* Change Management (KCM).

The *Kaizen*-Lean methodology at IBEROL was implemented with Total Flow Management, and Total Productive Maintenance methods of KMS, and with Project *Kaizen* and Daily *Kaizen* methods

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of KCM.

2.1. Total Flow Management

In TFM method, SMED (Single Minute Exchange of Die) tool was used in a PEU subproject, entitled "Start-up and Manufacturing Process Exchange Reduction Time", to reduce the time of production process exchange from rapeseed to soybean and vice-versa. SMED is a tool of Lean production, developed by Shigeo Shingo at Toyota, that reduces the global time of a procedure eliminating its inefficient steps [3]. The phases of SMED implementation are the following:

1. Study of the manufacturing process exchange, to record the preparation work implied, e.g. in video format, so all the tasks are identified and times measured;

2. Differentiate internal work (done with the machine turned off) from external work (done with the machine turned on) - e.g. with checklists for materials preparation;

3. Transform internal work in external;

4. Reduce or eliminate internal work;

5. Reduce or eliminate external work.

Afterwards, the optimized work is standardised and its duration is measured to analyse the improvement measures taken.

The Gantt analysis of the production process exchange identified the critical step as being the stabilization one, after the process start-up, and timed with 13h30m. To reduce this step time and reach a vertical start-up, the PEU operators have to simulate the desired process scenario sooner, but to do so, they need to consult the process variables, of certain equipments related to previous productions. This requires a database of process information, but there was no such tool, and the subproject was compromise at this point.

2.2. Total Productive Maintenance

In TPM method, Autonomous Maintenance (AM) and Planned Maintenance (PM) tools were implemented, in the context of subprojects. The former enables employees to perform basic maintenance operations, such as cleaning, inspection and lubrication of equipments, so the Electric and Mechanical Maintenance teams are available to focus on activities of higher value, and preventive interventions. It allows to restore the initial state of the equipment, implement a visual detection system of anomalies, eliminate fouling sources, improve equipment accessibility and standardize work procedures to maintain the equipment condition [4].

The latter is a preventive maintenance and complements AM. It is used to increase the equipments life time, to stabilize the time between failures and to attain the "zero failures" of equipments. PM is performed by the maintenance team and involves equipment evaluation, based on its criticality, list service priorities, estimation of maintenance costs, estimation of inventory, and creation of a failure and breakdown information system [5].

AM was implemented in the BPU team with maintenance circuits OPL's and TPM cards, in order to mark nonconformities to be repaired by the Maintenance teams. PM was implemented with a Risk Matrix, to map all process equipments, and a scheduling plan, to put in practice the preventive interventions. Both this tools were implemented without KPI's monitoring, and AM was not supported with an audit and activity record system.

2.3. Project *Kaizen*

One of the supporting pillars of KCM is Project *Kaizen*, in which the company proceeds with a *hoshin kanri* analysis (Policy Deployment) [6] and Value Stream Mapping [7] of its processes, so that improvement opportunities are pointed out and annual commitments are planned by the top management. This enables the development of *Kaizen* events, with teams set up for this purpose, that can be structured with the A3 tool. This tool manages a project or a problem solution in nine steps: Clarify the objective, Observe Initial state reality, Set targets, Analyse gaps and causes, Design solutions, Test solutions, Update action plan, Confirm targets, Lessons learned and actions. This A3 subprojects are monitored in the mission control room for *Kaizen* events, entitled *Obeya* Room or *Kaizen* Room [8].

In the beginning of 2015, a *Kaizen* Project Timetable was created with twenty six *Kaizen* events, in the form of A3 subprojects, relative to improvement opportunities identified beforehand [9]. To monitor and follow up this A3 subprojects, Steering Meetings were conducted on a monthly basis and a Steering Action Plan was created to monitor steering actions outlined. Despite this efforts, steering was not sufficient to promote the desired development of this subprojects, in other words, costs reductions, investments and subprojects conclusion for 2015 were not in the right pace, because, in comparison with the objectives outlined until July of the same year, only the following were accomplished:

- **87%** of costs reduction;

- **33%** of the investments planned;

- **36%** of subprojects concluded.

Only the profit margin was marking a superior result, trespassing the initial objective in **196%**, for the same time period.

The involvement of the company in *Kaizen* activities was also monitored, to quantify the engagement in the methodology implementation. Lean Events quantifies the *Kaizen* events and meetings that take place, annually. Like mentioned before, in 2015 there were 26 A3 subprojects, including the Daily *Kaizen* implementation subproject, supported with 12 annual Steering Meetings. The Daily *Kaizen* itself incorporated 5 daily reunions, 3 weekly reunions and 1 biweekly reunion.

The global engagement was **69%** of the company's employees.

2.4. *Kaizen* Audits

Before proceeding to the Daily *Kaizen* implementation overview, the audit system used must be described. The *Kaizen* methodology auditing process presents 3 types of procedures:

- The *Kamishibai* audits objective is to build routine among teams, regarding any kind of procedure that needs to be audited, e.g. to carry out the Daily *Kaizen* reunions [10]. It requires *Kamishibai* cards, which are made up of a set of questions that guide the auditor in an easy and simple way, to evaluate the procedure. If all the questions are answered positively, the team receives a green card and the audit is globally positive; if at least one of the questions is answered negatively, then the team receives a red card and fails the audit.

- The Daily *Kaizen* Levels are audited by questioning at least two team elements, chosen randomly, with a template specific for the Level that is being evaluated. For example, in the Level 1 audit the template covers 8 evaluation categories - Last reunion occurrence, Culture, Team, Reunion Standard and attendances, KPI's, Work plan, PDCA actions plan, Reunion dynamics. This categories are divided in subcategories, assigned with 1 (positive) or 0 (negative) values, and the global evaluation is weighted by the share in positive values. The Kaizen Institute, usually, uses the **75%** benchmark to assess if an evaluation is globally positive or negative.

- The *Gemba Walk* audits involve the first hand observation of *Gemba*, and is performed by a person external to the *Gemba*. There are 3 important factors to have in mind - the auditor direct observation, the place of value-added activities or workplace, and the group of workers that perform those activities. This audits intend to correct problems in work practices [8].

Any of the referred audits have a frequency appropriate for the company needs.

2.5. Daily *Kaizen*

Daily *Kaizen*, also a supporting pillar of the KCM, is a tool to develop and train teams responsible for a certain section or department of a company, which in Japanese is referred to as *Gemba*, meaning the place where the action occurs. It is divided in 4 Levels. Level 1 corresponds to the phase where the team is formed, the Daily *Kaizen* reunion is standardised and the team board is put in order [10]. Level 2 implies the organization and standardisation of the team's *Gemba* [11]. In Level 3 team's work procedures and activities are standardised [12]. Lastly, Level 4 [13] implicates analysis of improvement opportunities, identified by the team, and problems resolution, using the PDCA cycle [14].

Daily *Kaizen* was implemented at IBEROL in nine teams, before September of 2015. Those teams were BPU, PEU, Silos and Warehouses, Mechanic Maintenance, Electric Maintenance, Logistics and Commercial, Weighbridge, and Top Management. Previously to the leverage intervention, the general opinion towards the Daily *Kaizen* tool was of discontentment and disapproval, as it was seen as an imposition of extra work.

Daily *Kaizen* team performance was audit with Level 1 *Kamishibai* audits and Daily *Kaizen* Levels 1 and 2 audits, since the mentioned teams were all in Level 1 and the Electric Maintenance team was in Level 2. Regarding the *Kamishibai* audits, before leverage, the average of positive card questions was **60%** and the average of complete positive audits was **34%**. In the Daily *Kaizen* Levels 1 and 2 audits case, also before leverage, the average was **43%** and **17%**, respectively.

3. Implementation

The leverage intervention, for *Kaizen*-Lean Methodology implementation, was carried out with Microsoft Excel tools, to support some of the difficult points identified previously, as well as to implement Daily *Kaizen* Levels 1 and 2 in more teams, to modify Steering Meetings standards, to create audit systems for AM, Daily *Kaizen* Level 2 and team's *Gemba*, and to practice Continuous Improvement Training Sessions, to improve the teams Kaizen culture level.

Microsoft Excel tools were developed with the assistance of VBA code.

3.1. Technology&Development KPI's

The Steering Meetings were made monthly, to discuss the most critical A3 subprojects and Daily *Kaizen* developments, but since this frequency was not sufficient, the meetings were placed in a weekly basis. This way, all subprojects have the opportunity to be discussed at least once a month, in more detail.

The director of the Technology&Development department is one of the moderators of Steering Meetings, and this department is responsible for monitoring and manage all the steering data in the Steering Actions Plan. Since this department did not have KPI's, the improvement of Steering Actions Plan management was used to do so.

Steering Actions Plan is now standardised with a more completed database and a KPI dashboard, to follow the steering development of A3 subprojects and team's Daily *Kaizen*, to easily identify critical outcomes.

3.2. Steering Agenda

Since Steering Meetings occur more frequently, they need to be scheduled and planned more carefully. In this way, a scheduling tool was developed, where A3 subprojects are grouped in 4 or 5 groups to schedule the Steering Meetings occurring in each month. The grouping procedure takes into account interrelations that subprojects and teams may have, and can be modified whenever needed.

This tool helps to standardise the meetings programme, by allocating presentation/discussion time durations, and presenting the critical steering actions in development ate the time, by importing data from Technology&Development KPI's tool. It also imports data from Project *Kaizen's* timetable, relative to subprojects evaluation phases, so the follow up of pre-estimated project time duration set targets are not neglected. The Steering Meetings programme and scheduling are sent by e-mail to all the participating members.

3.3. Maintenance Steering

The Maintenance Steering meetings were created to speed up the development of AM and PM subprojects. The former needed an audit system, and so a tool to organise the AM routes, collect data from sections AM, monitor AM KPI's, was developed and implemented in partnership with the compressed air AM routes Excel tool development [15]. This tool is managed by the Maintenance Department and the auditing is performed by the Mechanical Maintenance chief.

The latter had a Risk Matrix tool to map all the process equipments, but it was not user friendly and did not monitor any PM performance. So, the Risk Matrix was improved with a KPI dashboard per company section and standardised input of data. In this way, the already existing Risk Matrix was improved to overcome this gaps, and now the Maintenance Director and the Top Management can consult the KPI's dashboards per section and intervene promptly at difficult and costly sections.

3.4. 5'S

Daily Kaizen Level 2 is implemented using the 5'S tool, which is a method to clean, organize and standardise the *Gemba*. At IBEROL, only the Electric Maintenance team was implementing this Level, but this implementation was interrupted for lack of supervision. As it was supposed for more teams to enter in Level 2, a Level 1 audit was conducted to analyse which teams were able to enter next Level, and so the Laboratory and Mechanical Maintenance teams were trained in 5'S and were assisted at the practical phase kick-off, despite only the Laboratory team had presented the right outcome at the Level 1 audit. The Mechanical Maintenance team was allowed to start the Level 2, because they showed a great level of discontent with the methodology and, normally, this Level brings more motivation and satisfaction with the positive *Gemba* alterations it brings in it. The experience was positive, because the Mechanical Maintenance team increased its satisfactions with the methodology, showing commitment with Level 2, and even got increasingly interested in doing Level 1 right.

This showed that more teams could do the same and take the example, but since this method takes a considerable amount of time, depending on the infrastructures and Gemba activities implied in each case, the recruitment of external help was made for teams that promptly wanted to start Level 2 of Daily *Kaizen*, even if Level 1 audit was not satisfactory. As a result, 7 more teams demonstrated interest in starting their Level 2, namely, BPU, PEU, Utilities Unit, Silos&Warehouses, Logistics&Commercial, Accounting and Treasury.

3.5. KPI's Portfolio

To analyse if the teams KPI's were the most indicated, data collection of KPI's was conducted and adjustments were made, to meet monitoring needs. Simultaneously, a tool to assemble all the teams KPI's monitoring was developed, so that top management and auditors could access this information when need. This tool includes a file that imports all the Daily *Kaizen* teams KPI's, and the teams monitoring files. KPI's may be monitored in personalised templates developed for which team, or in operations Excel "masks" [16]. An operations Excel mask is an Excel tool used by the manufacture teams (BPU, PEU, Silos&Warehouses, Utilities Unit) to calculate consumptions and productions, and to monitor teams KPI's.

3.6. *Gemba Walk*

Gemba Walk audits were used as a leverage method to supervise Daily *Kaizen* teams and their *Gembas*. A standard template was released and several audits were performed, resulting in nonconformity reports and action plans to solve them.

Today, this audits are performed by an external auditing company.

3.7. Continuous Improvement Training Sessions

To improve the teams *Kaizen* Culture, Continuous Improvement Training Sessions were implemented. Considering the majority of Daily *Kaizen* teams were in Level 1, this Sessions covered Level 1 training, with the subjects: Daily *Kaizen* methodology introduction, Paradigms, *Kaizen* principles, *Muda*, PDCA Action Plan, KPI, Work Plan, Attendance List, Open Communication Area, Audits.

The employees satisfaction with this sessions was evaluated with satisfaction quests. The result of quests was an average of 3.2, in a 0-4 scale. If the 75% benchmark is put to use in this case, it is possible to conclude the satisfaction level is positive, among Daily *Kaizen* teams. The teams that presented the lower satisfaction level were the PEU and Mechanical Maintenance teams, with 2,8 and 2,9 respectively. But taking in account the efforts this teams made to implement their Levels 1 and 2, this result may be interpreted as the teams elements demand for more training and information regarding practical outcomes of the methodology.

3.8. Work Plan Matrix

Work Plan and the PDCA Action Plan were misunderstood and the teams confused both, resulting in wrongful application of this tools on Daily *Kaizen* boards. To help avoiding switch of concepts, a Work Plan Matrix template was created, so that any Daily *Kaizen* team can use it to list their frequent tasks and plan daily or weekly work during Daily *Kaizen* reunions. This document is already in the company's Management System files for the Silos&Warehouses, PEU, BPU and Utilities Unit teams.

3.9. Seed Record

Considering the A3 subproject "Start-up and manufacturing process exchange reduction time", the PEU operators needed an operative instruction that could help them to simulate desirable stabilization scenarios. To overcome this gap, an Excel tool was developed to initiate a database with process variables (pressures, temperatures, amperages, etc) and feedstock quality. The tool enables the operators to consult the database with seed quality input. Through equation (1) the most similar seed is found and the correspondent stabilized process variables are displayed in an operative instruction template. The seed quality parameters are humidity (H), oil (O), protein (P), fibre (F), and ash (A) content in percentage. The VBA code runs the equation in the database and selects the smaller number calculated, S.

$$
\begin{aligned}
S = {} & (H_1 - H_2)^2 \left(\frac{H_1}{H_1 + O_1 + P_1 + F_1 + C_1} \right) + \\
& + (O_1 - O_2)^2 \left(\frac{O_1}{H_1 + O_1 + P_1 + F_1 + C_1} \right) + \\
& + (P_1 - P_2)^2 \left(\frac{P_1}{H_1 + O_1 + P_1 + F_1 + C_1} \right) + \\
& + (F_1 - F_2)^2 \left(\frac{F_1}{H_1 + O_1 + P_1 + F_1 + C_1} \right) + \\
& + (A_1 - A_2)^2 \left(\frac{A_1}{H_1 + O_1 + P_1 + F_1 + C_1} \right)
\end{aligned}
\tag{1}
$$

This facilitates the stabilization of the process after start-up and feedstock exchange (soybean to rapeseed and vice-versa). Since the database still has little data, the effect of this tool in the stabilization reduction time is not known yet.

4. Results

After the leverage intervention, new audits and satisfaction inquiries were conducted, and Project *Kaizen* KPI's were analysed. The same points referred in the beginning are described now compare with the previous scenario.

4.1. TFM

The A3 subproject "Start-up and manufacturing process exchange reduction time" is now supported with the Seed Record tool to help operators with operative instructions whenever they need to exchange the feedstock material and start-up the process. The objective is to reduce the **13h30m** stabilization time, but since the database is still in development the SMED time measures are not accurate yet.

4.2. TPM

TPM method includes the AM and PM subprojects. The former is now supported by the AM Excel tool to manage the AM routes, to register operators interventions in equipments, and monitor AM performance per sections. It also has an audit system implemented with training sessions, *Gemba Walk* and *Kamishibai* audits, conducted by the Mechanical Maintenance section leader.

The latter, is assisted by a more user friendly Excel tool, after the Risk Matrix improvement, and with KPI's monitoring per section. A Pareto analysis confirmed **80%** of maintenance costs are caused by **40%** of company's sections and **12%** of company's equipments. Both this A3 subprojects have now specific steering meetings to quickly solve problems inherent to which section that has AM and/or PM.

4.3. Project *Kaizen*

In the end of 2015, A3 subprojects followed up in Steering Meetings were evaluated, regarding their set targets and objectives, and the global curves of Cost Reduction, Profit Margin, Investments, and Subprojects Conclusion were outlined, in comparison with the initial state described in 2.

That year ended with **51%** of the reduction costs, **109%** of the profit margins, **128%** of the investments and **48%** of the subprojects conclusion objectives fulfilled. This curves can be analysed in Figures 1 - 3. The Lean Events showed 2015 ended with 31 A3 subprojects, due to alterations made during that year to IBEROL's Project *Kaizen*, and a 88% increase in steering meetings, due to the creation of Maintenance Steering and the weekly occurrence of standard Steering Meetings. The higher number of teams in Level 1 Daily *Kaizen* also increased the number of Daily *Kaizen* reunions, occurring today seven weekly reunions, five daily reunions, and 1 biweekly reunion. The engagement of the company in the *Kaizen*-Lean methodology was **82%**, in the end of the same year. Regarding the year 2016, IBEROL's Project *Kaizen* Timetable started with 24 A3 subprojects, also including the continuation of Daily *Kaizen* implementation subproject.
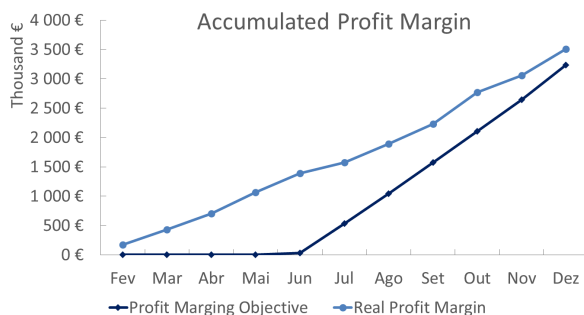
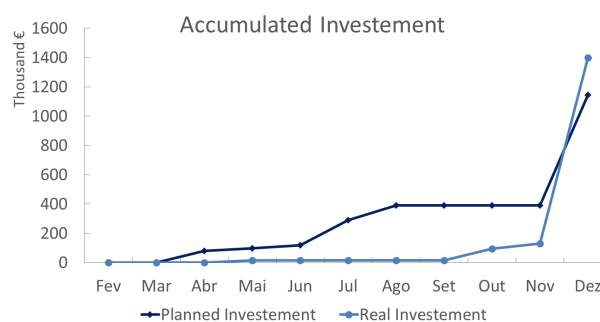

Figure 1: The accumulated profit margin curve.

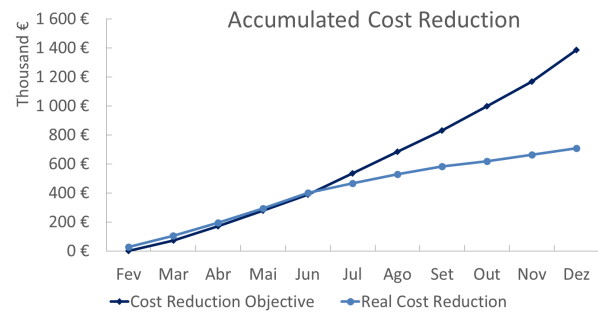Figure 2: The accumulated investment curve.

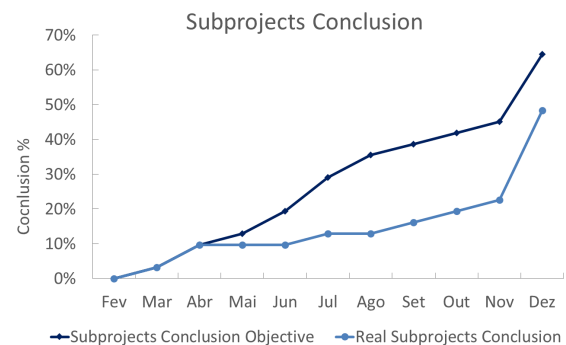Figure 3: The accumulated cost reduction curve.

Figure 4: The accumulated subprojects conclusion curve.

4.4. Daily *Kaizen*

In Daily *Kaizen* methodology more teams were introduced to Levels 1 and 2, resulting in the teams final engagement of **87%** and **47%**, respectively. The *Kamishibai* audits have now an average of positive answers of **68%** and an average of positive *Kamishibai* audits of **43%**.

The Daily *Kaizen* Level 1 audits have now an average of **58%**, and the Level 2 audits have an average of **49%**. The more fragile Level 1 category is now the Reunion Dynamic with an **43%** evaluation mark.

The Daily Kaizen motivation level has an average of **3.5** values, in a 0-5 scale.

5. Conclusions

Bearing in mind the scenario described in section 4, the conclusions taken are, regarding TFM method, the Seed Record Excel tool needs more time to grow the database, and afterwards measure the stabilization time taken when the operatives instructions are put into practice.

Regarding TPM method, AM Excel tool is implemented in the BPU, PEU, Silos&Warehouses, and Utilities Unit sections, as well as the audit system is already institutionalised. The Risk Maintenance tool is now more user friendly, and monitors the

PM performance with a KPI's dashboard per section. AM and PM are now supported by specific Steering Meetings to follow-up their developments.

Considering the Project *Kaizen*, the Steering Meetings are conducted in a weekly basis, with a steering actions plan standardised and with A3 sub-projects KPI's monitoring managed by the Technological&Development Department. The accumulated curves show the cost reduction could not meet the expectations, in the end of 2015. This was, mainly, because 50% of cost reductions A3 sub-projects have not achieved the KPI's monitoring phase and 20% of them did not gathered the right conditions to start. Global investment exceeded the objective because one A3 subproject surpassed the investment estimations. Having in consideration the subprojects conclusion objective, for the end of 2015, was 65% (due to alterations made to IBEROL's Project *Kaizen*), the real conclusion of 48%, in comparison, was low. This may indicate the number of annual commitments launched are too many and/or A3 subprojects team leaders are not managing their subprojects properly.

Regarding Daily *Kaizen*, more teams started their Levels 1 and 2, increasing the engagement in the methodology implementation. The majority of the teams increased their audits results, *Kamishibai* and Level 1 and 2, and their satisfaction level towards the methodology, resulting in the rise of the averages of this metrics. In general, it can be concluded the leverage of the methodology implementation was successful, but more efforts need to be made so all the metrics used surpass the 75% benchmark, the teams engage in Level 3 of Daily *Kaizen*, and all the events planned in Project *Kaizen* (A3 subprojects) can be completed in time and meeting the set targets.

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