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MODEL/FRAMEWORK FOR ADDRESSING CONTINUOUS IMPROVEMENT PROJECTS EFFECTIVELY AND EFFICIENTLY USING SIX SIGMA METHODOLOGY. CASE STUDY OF AUTOMOTIVE AUXILIARY COMPANY

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Abstract
The purpose of this work is to develop a model for implementing an effective and efficient Continuous Improvement projects, aimed at increasing the performance of production processes. In particular, it aims to innovate in the way of deploying a Program Improvement in the company to make this process run as efficiently as possible.
Although continuous improvement programs are some of the tools that are commonly used in industrial environments to increase the performance of their processes, it has become clear that there is a need to develop a continuous improvement model that will be implemented efficiently, and its results will remain over time. Also, it has been found that the model mentioned previously should serve to develop the foundations of an Organization which learns quickly and continuously.

Keywords
Continuous Improvement Model (CIM), Improvement Projects Resolution Process (IPRP), six sigma, productive efficiency, industry, continuous learning.

Introduction

In recent years, owing to the globalization of the economy, the increasingly prevailing role of new technology and changes to the productive model, industrial sectors have been experiencing great changes in all spheres of action, which along with the background of the current financial crisis, have generated an environment which is characterised by strong competition, which in turn forces companies to constantly adapt to market conditions which are hard to foresee. Due to this, organizations today have a constant need to reduce production costs, improve quality, reduce wastage in production lines and increase manufacturing output in order to both achieve and maintain competitiveness [1]. In this context, employing the Continuous Improvement Process (CIP), by continuously implementing improvements in all spheres of the organization [2], albeit not sufficient on its own, becomes a basic resource to generate a long term competitive advantage. Consequently, in recent decades, CIP has become an important element to increase corporate competitiveness by constantly improving Product Quality and the efficiency of production processes [3].

The need to implement a CIP

The Continuous Improvement Process (CIP) may be defined as “the process to constantly and gradually improve the different areas of a company, seeking increased corporate productivity and competitiveness” [4]. Further to this definition, more definitions may be added according to the goals sought or the approach to reaching them: "focussing corporate activities on improving process performance" [3, 5] "gradually improving the processes by progressive innovation" [6], "carrying out activities by involving all company employees from senior management down to production workers" [7] or "strengthening creativity and learning in order to develop an environment for growth" [8].

Implementing the CIP is no simple task and while the benefits of the CIP have been widely reported there is no "panacea" or "magic formula" to achieve the proper functioning of the CIP. The results of the efforts to improve are not always immediate and it may be some time before the benefits of incremental improvements are noted and the existing system must also be continuously enhanced, correcting defects and trying to always bring in something new to relaunch the system from time to time [9]. For this reason, it is often the case that after having obtained initial positive results from the aforementioned implementations, they have been impossible to maintain over time [10]. Many authors highlight the importance for organizations to have a good CIP, perform a meticulous follow-up of its deployment, adopt it to the distinguishing features of each organization implement it efficiently [1, 11] and [12]. Furthermore, they highlight the fact that this CIP should serve as a tool to build the foundations for an organization which learns rapidly and continuously [13].

Aims

In this research a model has been developed for the CIP oriented to improving productive efficiency to take place efficiently and be maintained over time. It targets innovation in the method for deploying a corporate Continuous Improvement Process so that this process is deployed as efficiently as possible. To this end work has taken place on the project implementation phase based on the team-project pair in the Improvement Projects Resolution Process (IPRP), in order to identify all the elements influencing this process.

Research methodology

The methodology used is based on the "case study research" [14], particularly appropriate to the development of theories oriented to explain how and why organizations operate [15]. According to the action research methodology, a researcher is a not an independent observer, but a participant in the process [16]. Unlike other research methodologies, action research is concerned with creating organizational change and simultaneously studying the process involved [17]. Therefore, members of the organization being studied actively participate in the process, as well as the research.

In this case the researchers have taken an active role in the implementation and monitoring of 28 projects in three case studies. This fact has allowed the identification of different aspects to improve or promote the model used. The phases of the methodology, used in the research project are:

1. MMC-IKASHOBER Design: Firstly, the Continuous Improvement Model (CIM) was designed and named MMC-IKASHOBER, for which the basic elements of the CI and the key aspects of the Organizational Learning (OA) have been identified.
2. PRPM-IKASHOBER Design: Subsequently the Improvement Projects Resolution Process (IPRP) was designed and named PRPM-IKASHOBER, and based on this process the MMC-IKASHOBER was deployed by implementing the Case Study's (CS).
3. Fieldwork: The fieldwork was approached by sequentially implementing CS's in three phases where 28 improvement projects were analyzed according to the guidelines set out in the PRPM-IKASHOBER.
4. Results and conclusions: In this section the global reflections and conclusions on the fieldwork carried out are outlined.

MMC-IKASHOBER Design

For the design of the Continuous Improvement Model which was named MMC-IKASHOBER, the basic elements of the CI and the key aspects of the OL have been identified.

Continuous Improvement basic elements

There have been many studies which have identified the elements related to CI which should be taken into account when designing a CIM. As a rule, most studies agree on the aspects mentioned although each highlights the importance of different elements according to the approach of the study carried out. The studies mentioned mostly agree on the elements to be taken into account and, as seen in Fig. 1, they are the following:

E1: Commitment of the management. In order to address a CIP it is necessary to have management support and involvement [5, 18, 19], with a management styles which encourages the CI in the organization routines and processes [20] and to this end it is necessary to define a lead team to direct the CI process [21–23].

E2: Company culture. In order to induce cultural change it is necessary to develop new behaviour and routines for all members of the organization which involves continuous learning and generating a high level of organizational learning [13]. Overcoming resistance to change using communication and ensuring that the CIP creates benefits [5, 18, 19, 24].

E3: Strategy. The CIP should be a strategic part of the plan of operations which helps to create benefits on the different strategic levels through taking skills learnt from the CI and turning them into routines [13, 25].

E4: Leadership and structure. There must be an organizational structure dedicated to CI which takes care of designing the strategic goals and responsibilities, managing the budgets, and designing and applying a system to measure the improvement [26]. A structural model which integrates seamlessly into the organization is what the Six Sigma methodology proposes [27].

E5: Resources. Financial resources, release from other tasks for those taking part in the CIP and time for training must all be made available [10, 18, 22].

E6: Projects. The Projects must be clear, powerful, specific, feasible, realistic, and measurable and must have a strong possibility of succeeding. They should be management selected, in line with strategy and should help towards generating value for the client [28].

The Projects should be used as learning elements and the level of difficulty of the Project and the skills to be developed which are expected from the teams working should be taken into account [29].

E7: Areas. Focus must be placed on the critical processes, process improvement must be thoroughly carried through and the impact of this on the general context of the organization must be taken into account [30].

E8: Operational method. It is necessary to have in place an RSP operational method based on the PDCA cycle and its respective tools [23, 26, 31].

E9: Training. Specific training must be designed based on the skills and behaviour to be developed at all levels. The contents of this training should basically involve the operational method and its respective tools for improvement both for related techniques and the personal relationship between people such as communication, problem-solving techniques and teamwork [32]. The learning process should be based on the Kolb cycle [33] and the Learning-by-doing educational model [34].

E10: Management and follow-up. A CIP follow-up process should be established [10], defining the indicators based on the efficiency, effectiveness and learning developed in the CIP [11].

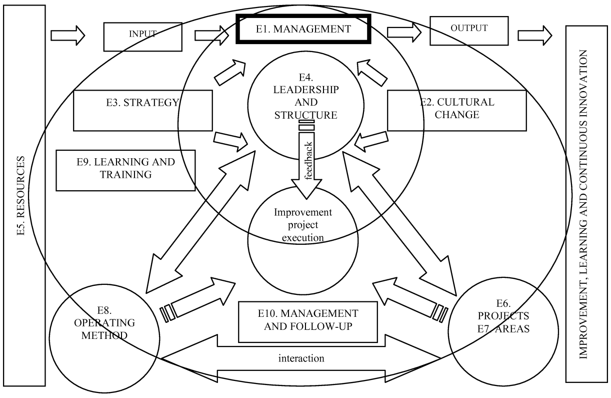

Fig. 1. CI Basic elements (based on [11]).

Organizational Learning aspects

In addition to this, the importance of developing capacity for learning has been highlighted in the definition of an OL model. The model is based on the fact that in the organizations adopting a PRPM-IKASHOBER 2 activities clearly requiring continuous learning can be identified [35]:

- Learning to Solve Problems,
- Learning to Avoid Problems.

In order to learn to Solve Problems it is necessary to have Problems in the hands of those responsible for learning this skill or ability. Each of these persons starts from a Mental Model [36] on how to perform this activity, a model which is in general neither very elaborate nor systematic and they will modify and perfect this as they gain experience [33]. As such this involves skills building based on Problem Solving procedures.

In order to learn how to Avoid Problems the starting point is a Mental Model of the system addressed with agents and relationships and this involves acquiring new skills regarding the way it works which change the decision-making process. As a consequence existing operational procedures are modified.

In Fig. 2 we can see the learning model developed for the present model and here we can see that learning is generated in two spheres. The first relates to the area itself where the improvements are applied, where as the projects are implemented using the DMAIC methodology and as the goals are achieved, the new routines are identified which help to change behaviour at the operational level for the area process to be more efficient and more effective.

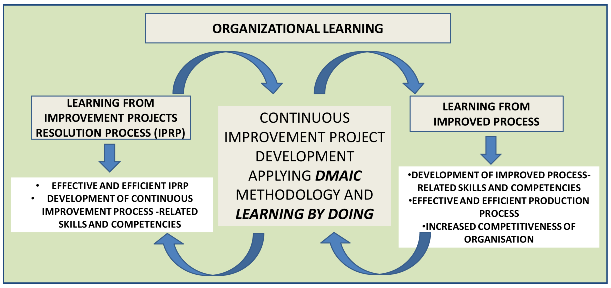

Fig. 2. OL Model (own study).

The second sphere involves where the CIP learning takes place since as the projects are implemented the results of the application of the methodology, the development of the activities and so on are assessed.

The development of the improvement process in itself is observed and new routines are identified which assist individual skills building and which lead to the CIP developing in a more effective and efficient manner. The process follows for this is shown in Fig. 3 and is the following:

1. The individual applies the methodological skills acquired (DMAIC) with the aim to build up know-how or problem-solving skills. The continual application of methodological skills on different experiences to projects leads to variations and improvements in the way that the individual responds and manages to deploy the Know-How to the PRPM-IKASHOBER. For individuals to achieve the skill to carry out a task it is necessary to design routines which through repetition lead to acquisition of the given skill. The given routines are shared and form part of the organizational knowledge base on PRPM-IKASHOBER.
2. In order to be able to design routines it is necessary to know the Know-Why, that is why things work as they do. The individuals who know the CIP should design routines so that when the CI projects are implemented the teams try to build up problem-solving skills based on repeating these routines. Designing CIP routines is the trainer's responsibility.
3. When in a project the root cause is identified and it is known "Why" the process does not work, the Know-Why is understood. So the team, with this knowledge, has to make the affected environment change and to this end must design routines to facilitate the skill which enables the process to be improved.
4. The persons who acquire the skill go on to a different level and a modification to the mental models is produced. If they understand why they do certain things they can even improve their processes without the need for trainers as if it were an automatic process.
5. The individual and their team, using their process knowledge, draw up or modify routines which are to be incorporated into the organizational knowledge base.

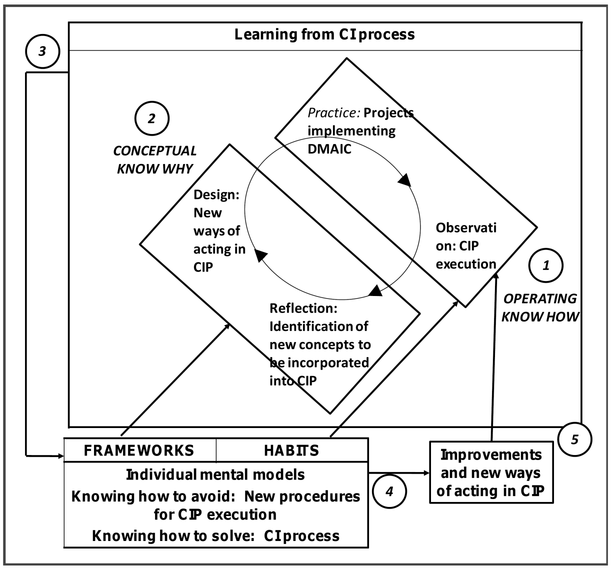

Fig. 3. Learning cycle developed with the PMPM-IKASHBER (Based on [37]).

It must be taken into account that the PRPM-IKASHOBER routines are drawn up by an expert team in PR methodology which has a strong understanding of the Know-Why of PRPM-IKASHOBER. This means it is necessary that it be a CIP trainer who improves the CIP and in each organization a start will be made in certain areas according to the goals.

The routines identified for the system affected are drawn up by the team working on the project which has a strong understanding of the Know-Why of the process on which the Project is deployed.

MMC-IKASHOBER Implementation

In order to implement the model it is the Management (E1) that is responsible for encouraging the cultural change (E2) that the CIP implementation will bring about. The Management should communicate to the entire Organization the benefits brought by the CIP and should bring them into line with the strategy (E3).

The process should be led (E4) through a Management representative who promotes the CI in the Organization processes and routines. A structure

(E4) must be developed which is dedicated to encouraging the CI (Lead team), which will have the necessary resources (E5).

The core activity of the CIP is the Improvement Projects Resolution Process (PRPM-IKASHOBER). This is deployed by the interaction of three elements: the Lead team (E4), the projects (E6) and areas for improvement (E7) and the improvement operating methods (E8). The Lead team should identify the areas for improvement and should define the improvement projects suitable to be carried out in the selected areas, as well as the training requirements (E9). These projects are carried out with improvement team dynamics, using the respective approaches and tools. By continually implementing the projects, within the Organization the capacity for learning, improving and innovating will be generated.

According to the OL model proposed and as the CI projects are deployed using the DMAIC methodology, learning is generated in two spheres: in that related to CIP and in that related to the process for improvement. This learning process leads to change in the personal mental models and people in turn generate new skills which are integrated both into the CIP and the improved processes. The cycle repeats itself and this leads to the CIP sphere of PRPM-IKASHOBER being implemented in an efficient and effective manner.

Deploying PRPM-IKASHOBER

The PRPM-IKASHOBER has been set up as a process within the CIP which creates value in an organization and to this end the stages and phases have been identified. In these stages all the key factors of the CIM are outlined and the CIM structure is shown in Fig. 4.

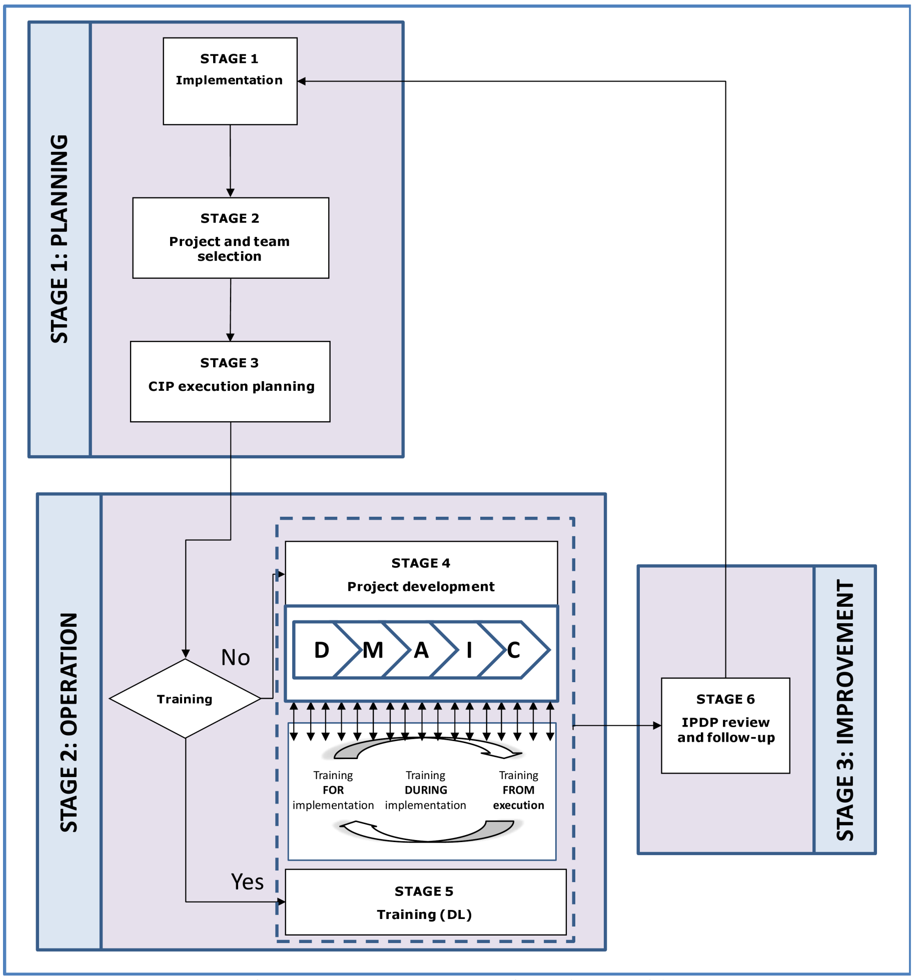

Fig. 4. PRPM-IKASHOBER Phases (own study).

Stage 1: Planning

Initially the committee promoting PRPM-IKASHOBER will identify indications and behaviour which ensure support from Management and from those responsible for the different Organization areas for PRPM-IKASHOBER [11, 38]. Furthermore, the operational part of the PRPM-IKASHOBER which is considered to be most suited to the reality of the organization and which enables the proposed goals to be achieved should be designed. In addition to assigning and managing the necessary resources to address the PRPM-IKASHOBER [11, 39].

The channels, activities and tools enabling communication and information flow to all Organization employees concerning the features and benefits of the PRPM-IKASHOBER should also be developed as well as the acquisition of the new routines by all those involved [13].

Having set up the PRPM-IKASHOBER, the Lead team, working with the line managers of the different areas of the Organization, will go on to analyse the critical processes so as to identify the Improvement Projects which have the suitable features to be worked on in this improvement process [40], as well as the persons with the suitable profiles to form part of the teams. In this case, the same structure as that in the Six Sigma methodology will be followed, such that in this phase the Management delegate in charge of promoting the project (Champion), the person in charge of leading the project (Leader) and the Team members should all be identified [41]. In this phase, the persons who are to receive skills building training in PRPM-IKASHOBER should also be identified as well as the projects which will be used as support in this training.

In conclusion and with the aim to visualize the dimensions of PRPM-IKASHOBER, the next step will be to design the training plan and the plan for all the PRPM-IKASHOBER-related activities (information, communication, project implementation).

In the aforementioned plans a forecast and a scheduled plan for the necessary resources will be drawn up, indicating who will supply these resources and when they will be used [10, 18, 22].

Stage 2: Operations

In the operating stages of the PRPM-IKASHOBER two possible plans of action or phases, to take place in parallel, are considered. The first is that relating to the actual project implementation, where the Team deploys the skills linked to the problem-solving process and teamwork skills with the aim to successfully achieve the project goals.

The second concerns that of training the Team leaders by implementing projects using DL (Dynamic Learning). In this phase the Research team will come into play and will observe and act on the team-project pair with the aim to implement the CI projects effectively and efficiently. In order to deal with this phase the adaptation of the training programme to individual needs and those of the Organization should be taken into account [29, 32], as well as the role of the trainer [42], as the trainers are seen as key factors to achieve the goals of the CI project.

The training model takes the foundations of the "Dynamic Learning" (DL) [43], DL establishes a framework that integrates various approaches for the organization of training. This concept is of special interest, starting from the idea that in the present context it is essential to perform training more quickly by integrating learning in the organization and enabling it to occur in real time.

According to this view, each of these phases has its own constraints and objectives:

Training FOR implementation: it is a preparation phase and therefore executed prior to implementation. The aim is to enable the transfer of knowledge through formal training and training that each individual needs and when he/she needs it. The aspects taken into account in the theoretical training are related to the objectives of imparting training. At this point we define the contents of the training, how in the MC method used.

Training DURING implementation: this is a phase of simultaneous learning while performing the project, which in turn allows a better understanding of the concepts. Thus, in its design some facts have taken into account, such as how to incorporate the theoretical training into the implementation of those projects, the design of the models and procedures to be followed, the surveillance to be performed by management and the ways to disseminate knowledge generated within the organization.

Trained FROM execution: it is based on thinking about what has been done, and permits the consolidation and systemization of the lessons learned, along with the identification of opportunities for future application.

Stage 3: Improvement

In the PRPM-IKASHOBER Improvement stage, the members of the Lead team will periodically review and assess the level of accomplishment of the established goals [10, 44] for the PRPM-IKASHOBER, based on criteria for effectiveness and efficiency. In addition to the assessment regarding the PRPM-IKASHOBER itself, the Lead team, along with those in charge of the projects, should periodically review the progress of the improvement projects as well as the effectiveness of the methodologies and techniques used. Furthermore, once each DMAIC phase is brought to a close, the Lead team, together with those in charge of the projects, should also review the evolution of the training process and the progress of the projects addressed with this goal in mind in terms of effectiveness, efficiency and learning. The deviations encountered in all the assessments will be corrected with specific actions which will be incorporated into the operating plans. Those actions which have led to an improvement will be adopted as new operating standards.

Applying the PRPM-IKASHOBER

The model has been implemented and improved by implementing the CS in three consecutive phases in the 2007-2010 periods in different companies in the automotive auxiliary and household appliance sectors belonging to the Mondragon cooperative group. The aforementioned group is the largest business group in the Basque Autonomous Community and the seventh in Spain.

The application contexts have varied according to the CS's addressed. Following describes each case study based on the context where they have been applied.

Case Study 1-CS1

In CS1, the 8 cases have been implemented [45] in 4 different companies from the aforementioned industrial group and in a context where the management was committed to the CI and willing to experiment with a CI methodology aiming to see indications of the influence of elements of the previous CI models and to identify aspects for improvement and hypotheses. The following paragraph shows the characteristics of the different organizations and projects carried out in each one of them.

Organization A: It is a medium sized industrial organization engaged in the manufacture of components for the household appliance industry. It has different plants worldwide and is a leader in its sector. This organization has undergone a radical transformation over the decade of the 90s, due to a continuing need for improvement in quality, cost and delivery. From a strategic standpoint, the organization has developed and implemented a structure that develops the CI and provides training programs for basic tools equipment in CI, however, the performance of teams tackling projects of medium difficulty complexes can be improved in the opinion of the Management. It has addressed the following project, CS1 P1: Stock management, CS1 P2: Efficiency of 'Chiron' lines.

Organization B: It is an organization of automotive parts sector which manufactures through mergers and machining different parts for the automotive industry. It takes decades using different systems of continuous improvement. From a strategic standpoint, the acquisition of identified high-level skills in the CI, as strategic elements to stay competitive in the market through quality and project work as a method for achieving this end. It has addressed the following two projects, CS1 P3: Fill lacks and CS1 P4: Emission control.

Organization C: It is a medium sized industrial organization engaged in the manufacture of cards for the appliance and automotive industry. It has different plants worldwide. From a strategic standpoint, the Organization has an advanced system to manage the activities of CI. One of the managers see an interesting increase technical skills and integrate it into a process that generates high defective and work on a project to increase the skills of staff of that process. It has addressed the following project, CS1 P5: Defective in the welding process.

Organization D: It is a medium sized industrial organization engaged in the manufacture of electronic components for the household appliance industry. From the strategic point of view, quality is a differentiator key, and the task of managing and promoting the activities of CI lies with production managers. The aim of the organization is to increase the skills of the people who are responsible for the production areas of new business and are, therefore, selected projects associated with new areas where these people have been integrated. It has addressed the following three projects, CS1 P6: Leak control, CS1 P7: Design of induction devices, CS1 P8: Welding of the bun

Evaluation system in CS1

The evaluation of the model has been leading by the researchers involved in the project (who have assumed the role of trainers), in collaboration with the project leaders and the members of the management of the company. In this case the evaluation of each project was made based on considering the level of achievement of the objectives, and identifying the strengths and weaknesses observed in implementing the projects. This evaluation was carried out three months after the project finalization using questionnaires based on interviews.

Results and Concluding remarks in CS1

Figure 5 shows the results of the % achievement of the objectives for each project in CS1. It shows that in cases CS1P6, CS1P7 and CS1P8 do not achieve the expected results in any of the three cases, this is because the projects have been stopped by difficulties of working on them and that is why the objectives have not been achieved. In order to achieve competencies of people, in these cases, custom activities have been done to fill gaps due to not being able to perform as scheduled experiences.

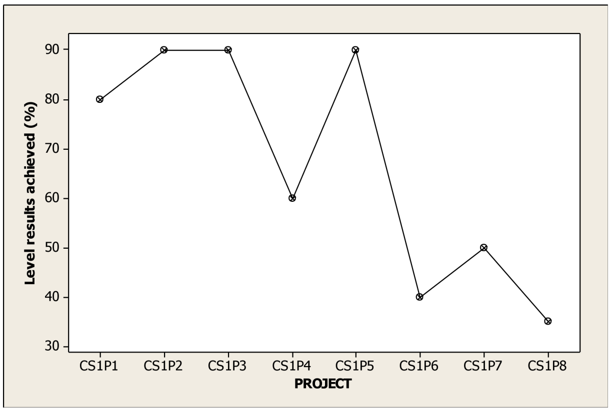

Fig. 5. Results of the% achievement of the objectives for each project in CS1 [own study].

The same goes for the case CS1P4 for technical deficiencies in this case, towards the achievement of competencies of the team leader, the case has taken advantage of the case CS1P3 developed in the same Organization, as support experience CS1P4 leader.

In other cases, the achievement of objectives is high level, with the overhead (not reached 100%) due to different reasons. In cases CS1P1 and CS1P2, although the dynamics of project implementation have been very positive, difficulties have been identified of generating habits regarding the application of the improvements, which have not allowed to reach 100% of the targets.

In the case of CS1P3, targets have been achieved by disciplined team, forming a leader with skills in problem analysis, based on data, management indicators and improvement proposals. All with strong people management skills. In this case, it has not been reached 100% of the targets because of a lack of funds to address the standardization of automated improvements.

In CS1P5 the team has been able to identify key process factors analyzed (Know-Why) causing defective crisis, through the application of the tool factorial design experiments in a very participatory way by all those involved in the process. The team values as key tool for the job in the future environment.

Case study 2 and 3 (CS2 and CS3)

Apart from this in CS2 [46] and CS3 8 and 12 cases have been implemented, on different plants of the Organization A described in CS1. The following paragraphs show the characteristics of the different plants:

Plant A: It is a medium sized manufacturing plant employing about 400 people dedicated to machining cast iron brake discs. This plant is a premier supplier in the automotive industry. Over the past four years they have applied dynamic structured problem solving by improvement teams. In this plant we made these projects: CS2P1: Reduction of defective disc hub. CS3P1: Improved levels of noise and jump in parts and CS3P2: Increased capacity in the measurement line.

Plant B: It is a medium-sized manufacturing plant which employs about 500 people engaged in the elaboration of suspension parts for cars. This plant is equal to plant A concerning the implementation of quality systems and CI dynamics is identical to that of plant A. In this plant we made these projects: CS2P2: Control of the painting process of parts obtained through casting. CS3P3: Study of the effects caused by heat treatment in casting, CS3P4: Reduction of sink marks defective, CS3P10: rework reduction in coating parts and CS3P11: Improve the mold of the fusion process.

Plant C: This is a medium sized manufacturing plant employing about 300 people who produce aluminum calipers. The plant dynamics does not consider any structure to address the activities of CI. In this plant we made these projects: CS2P3: Reduction of overall defective in the caliper. CS3P12: Reduced defective by broken parts.

Plant D: It is a medium-sized plant (about 200 people) that manufactures high-pressure injected aluminum cylinder head covers. This plant is identical to plant A plant from the point of view of implementation of quality systems. On this floor it is usual to joint dynamic teams with Kaizen Improvement [7]. In this plant we made these projects: CS2P4: Reduction of internal and external defects of the cylinder head cover, CS3P5: Reduction of defective injection process breechblock and CS3P6: Reducing internal and external defective cylinder head cover

Plant E: It is a medium sized manufacturing plant employing about 300 people engaged in the production of cylinder block merged in green sand. This plant is identical to that of plant A from the point of view of implementation of quality systems. On this floor dynamic Kaizen Improvement teams [7] cohabitate but there is no analysis of numerical data. In this plant we made this project: CS2P5: Reduction defective block stock.

Plant F: It is a research center that supports the research and industrialization projects of the different plants described in the preceding paragraphs where they work 50 employees. This plant, concerning quality systems, is identical to plant A: they are very familiar with the research, experimentation and teamwork but they do not have any standardized model. In this plant we made these projects: CS2P6: Analysis of noise in the brake unit. CS2P7 Analysis of thermal behavior of injection moulds. CS2P8: Study of the main factors in the raw material for the smelting process of brake discs. CS3P9: Savings in raw material in the fusion process

Evaluation system in CS2 and CS3

In this case the evaluation of CS2 and CS3 were addressed differently to the CS1. For this, the evaluation of the model in CS2 and CS3, has been led by the researchers involved in the project (who have assumed the role of trainers), in collaboration with the project leaders and the members of the management of the company. They completed a questionnaire [47] specifically designed based on the following scale of Lykert (1 None, 2 Low, 3 Medium and 4 High), and valuing each project considering the following aspects: effectiveness, efficiency ,and learning. It has set a target for each aspect minimum value of 2,5, and they have subsequently identified some strengths and aspects to improve the model itself.

Results and Concluding remarks in CS2 and CS3

Figure 6 shows the overall average values of the aspects analyzed for each project developed in CS2. There is a summary below the findings and conclusions of each aspect. Following describes the behaviors observed, the findings and conclusions of each aspect in the implementation of projects.

Effectiveness CS2: It notices that the project has clearly had the worst performance from the point of view of efficiency of systematic is CS2P3. This case has been a case of risk from the start due to the selection of the project, and the team in an organization with strong labor problems, directly affecting the leader and the next address. Consequently, there is a case that the results achieved at the end of the period, which takes place in an inappropriate environment, and the learning objectives expected have not been achieved.

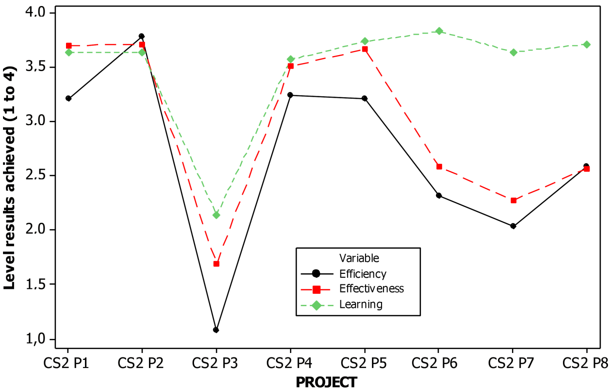

Fig. 6. Level of the results achieved in each project in CS2 [own study].

The following projects have underperformed in terms of efficiency projects are systematically CS2P6, CS2P7 and CS2P8. These projects have been executed in the plant F, which corresponds to the research center. Many weaknesses have been noticed when standardize improvements. This is because the three leaders do not use properly the standardization process to consolidate the identified improvements. For the rest of the projects (CS2P1, CS2P2, CS2P4 and CS2P5) levels of effectiveness have been positive.

Efficiency CS2: In terms of efficiency, it should be noticed that in all projects the same patterns are repeated as those shown for effectiveness.

Learning CS2: In all cases excepting CS2P3, achieved learning levels have been high and have been found to have acquired leadership skills previously unavailable. Furthermore it should also be observed that in cases CS2P6, CS2P7 and CS2P8 have had difficulties in applying the methodology in an effective or efficient way, they have had difficulties in the area of learning generated and this is fully appreciated. That caused a change in behavior in everyday activities, routines keep changing on the way of dealing with similar projects that involve simulation tools or vibrations in the parts with more advanced methodologies.

Figure 7 shows the overall average values of the aspects analyzed for each project developed in CS3.

There is a summary below the findings and conclusions of each aspect. Following describes the behaviors observed, the findings and conclusions of each aspect in the implementation of projects.

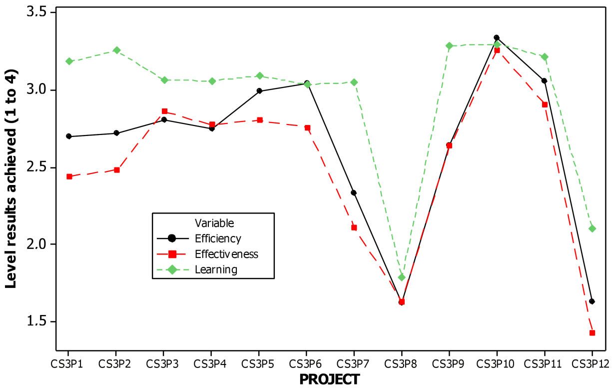

Fig. 7. Level of the results achieved in each project in CS3 [own study].

Effectiveness CS3: In this aspect weaknesses observed in projects CSP12 and CS3P8, which have not reached at any time the level 2,5 marked efficacy endpoint reference. Another project in which there have been low levels of compliance is CS3P7, the project has had a negative behavior when running to analyze, implement, consolidate and standardize. Moreover, in most projects undertaken (CS3P1, CS3P2, CS3P3, CS3P4, CS3P7 and CS3P9) weaknesses have been found when standardizing improvements. The projects that have had a positive performance have been the CS3P5, CS3P6, CS3P10 and CS3P11.

Efficiency CS3: In terms of efficiency, it should be noticed that in all projects the same patterns are repeated as those shown for effectiveness.

Learning CS3: In Fig. 7 it can be seen that in all projects excepting CS3P8 and CS3P12, achieved learning levels have been high. Although they had difficulties getting the results or the methodology applied in an effective or efficient way, leaders have acquired skills that previously were unavailable.

Results and conclusions

The general objective of this research project was to present a model for Continuous Improvement, developed and improved through its application in different companies, using the action research methodology. The most important concluding remarks derived from these applications of the model are oriented to several aspects:

In those projects where the Management did not play a role, the results were weaker as far as accomplishing the systematic process; accomplishing objectives and the learning developed are concerned. The Management has to know the process and its role as well as the main features of the training programmes to be implemented.

Weaknesses have been found stemming from the "the lack of bringing the projects addressed into line with corporate strategy", "relating to the research sphere" and being "excessively wide-ranging" or "technically complex". And the need for a prior effort in project selection is highlighted so that unsuitable projects are not chosen which might have the main effect that the DL training is not carried out and that the routines do not go according to plan, as well as projects having to be brought to a close without having reached the set objectives, something which occurs frequently. This creates a lack of motivation among the leaders and distancing of those in charge of the PRPM-IKASHOBER.

It has also been stated that it is important that the projects are carried out in areas with stable work environments and that they culturally assume the guidelines and goals established by the PRPM-IKASHOBER.

Deficiencies and weaknesses have been observed regarding the profile of the leaders concerning the teamwork skills, analysis and diagnostics, technical knowledge of the issue in hand and the time availability of the leaders to deal with the projects. The need to carry out a prior effort to choose the persons to lead the projects, recommending methodical persons who are persevering when faced with difficulties, with diagnostics skills based on continual questioning and statistical thinking and having communication and team leading skills as well as the time available, has been highlighted.

The operating routines and the skills which should be developed by the Teams in order to be able to deal with the projects effectively and efficiently have been identified and applied. The activities which took up most of the work have been data gathering and analysis, diagnostics and communication. To this end, routines have been carried out which are oriented towards the use of a scientific approach, the statistical thought process and proof-based communication, both during the cause analysis phase and in the phase for planning and implementing solutions which have a high impact on the root cause of the problems. The key element is defining the quantity of data which is needed and the way to obtain this data, it is also necessary to develop the skill for planning an experiment in order to obtain the maximum information with the minimum experimental effort, without forgetting the way to analyse this.

It has been stated that statistical thinking is the most complicated to instil. The Research team believes that promoting the capacity to imagine evidence is a good path to achieve the end as this enables the decision-making cycle to start up in a planned fashion in addition to properly channelling the data gathering process [35].

Another activity which has taken up a lot of the work has been developing robust standardisation systems, aiming to systematically integrate the improvements identified.

Furthermore, communicating the results to "convince" the Organization and bring about organizational training which leads to a behavioural change is an important activity. Communication must be based on showing evidence, founded on good data-gathering, which brings in new ways to manage the areas addressed.

Some elements developed by the Organization where the CS's have been implemented can be used for others yet it is unlikely that these will be as effective or efficient in their application as they were for the environment in which they were developed because both in the design and in the mode of application, culture-related elements, organizational structures, and the training skills and approach of the persons participating in the training design process have all intervened.

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