Framework to Evaluate Continuous Improvement Process Efficacy: A Case Study of a Capital Goods Company

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ABSTRACT

Purpose: This document describes a continuous improvement process assessment system (CIPAS). A continuous improvement process (CIP) was developed to progress through the levels of continuous improvement (CI) defined by Bessant, Caffyn and Gallagher (2001), and the CIPAS was developed to measure this evolution. The CIP and the CIPAS were tested in a mature industrial small and medium-sized enterprise (SME) cooperative company (Basque Country, Spain) that works in the capital goods sector.

Methodology/Approach: The study was developed according to an 'action research' strategy (Coughlan and Coghlan, 2002) over a period of two years. The action research team includes the authors and managers of several areas of the studied company.

Findings: The assessment identified critical elements and related routines for the effective execution of the CIP in this company. In addition, the evaluation system allowed for a visualisation of the company's CI maturity level progression.

Research Limitation/implication: The assessment system was designed in an ad hoc manner for this CIP and this industrial company, but it may be possible to adapt these to other types of companies by using the steps followed and indicators defined as an example.

Originality/Value of paper: The CIPAS is used to identify the key CI elements, to measure the evolution of CI routines, and to identify a CI maturity level of the company in which the CIP is applied. It can be applied to any type of company and serves to define future actions for its evolution.

Category: Case study

Keywords: continuous improvement assessment; continuous improvement process; industrial case study; action research

1   INTRODUCTION

The results of implementing continuous improvement (CI) have been well documented in the literature (Bhuiyan and Baghel, 2005; Marin-Garcia, Pardo del Val and Martín, 2008; Singh and Singh, 2015). However, in many cases, once CI techniques have been applied, the initial results are not maintained and become much less effective as time passes (Dale, 2015). For this reason, many authors insist that CI systems must be adapted to individual organisations (Singh and Singh, 2015). Organisation must define a CI deployment strategy to select the appropriate CI method and tools, and they must monitor and follow up in a structured manner with the CI system to develop a CI culture and CI routines and behaviours within the organisation (Bateman and Rich, 2003; Wu and Chen, 2006).

According to Jorgensen, Boer and Laugen (2006), an increased CI maturity level – in terms of the level of adoption of CI routines and behaviours – corresponds to an increased level of performance in the organisation. Several models have been developed to implement CI systems and explain CI sustainability (Upton, 1996; Bessant, Caffyn and Gallagher, 2001; Ljungstrom, 2005; Wu and Chen, 2006; Kumar, Antony and Tiwari, 2011; Egiguren, 2012; McLean, Antony and Dahlgaard, 2017). Taking as a reference previous models, the research team developed a continuous improvement model (CIM) to deploy improvement routines and develop a CI organisational culture, with the objective of increasing CI maturity. Furthermore, a continuous improvement process (CIP) was developed according to this model to define the steps and activities to follow to achieve this CI culture. To evaluate the evolution of CI organisational culture, the present study developed a continuous improvement process assessment system (CIPAS). The current paper presents the aforementioned work and how over a period of two years it was applied in an industrial small and medium sized enterprise (SME) company, here implementing the CIM to overcome the 2nd level and to establish the bases of the 3rd level of CI maturity.

The current paper is organised as follows. In section 2, the research methodology is presented. In section 3, the CIM and CIP are presented, and in section 4, the CIPAS is shown. In section 5, results are drawn from the application of the CIPAS, and finally, section 6 provides the conclusions.

2   METHODOLOGY AND SCOPE OF APPLICATION

The methodology was based on a case study (CS) investigation and embedded multiple units of analysis (Yin, 2013), in the same context was analysed eight units. The research was carried out in a single organisation or context, where the same process was replicated in multiple areas – each one considered a unit of analysis (UA) – to achieve a global understanding of the situation and the change caused in the organisation as a result of the changes carried out in each area. The

CIPAS was developed to assess the implementation and evolution of the CIP. The UAs were divided into three groups based on their common characteristics.
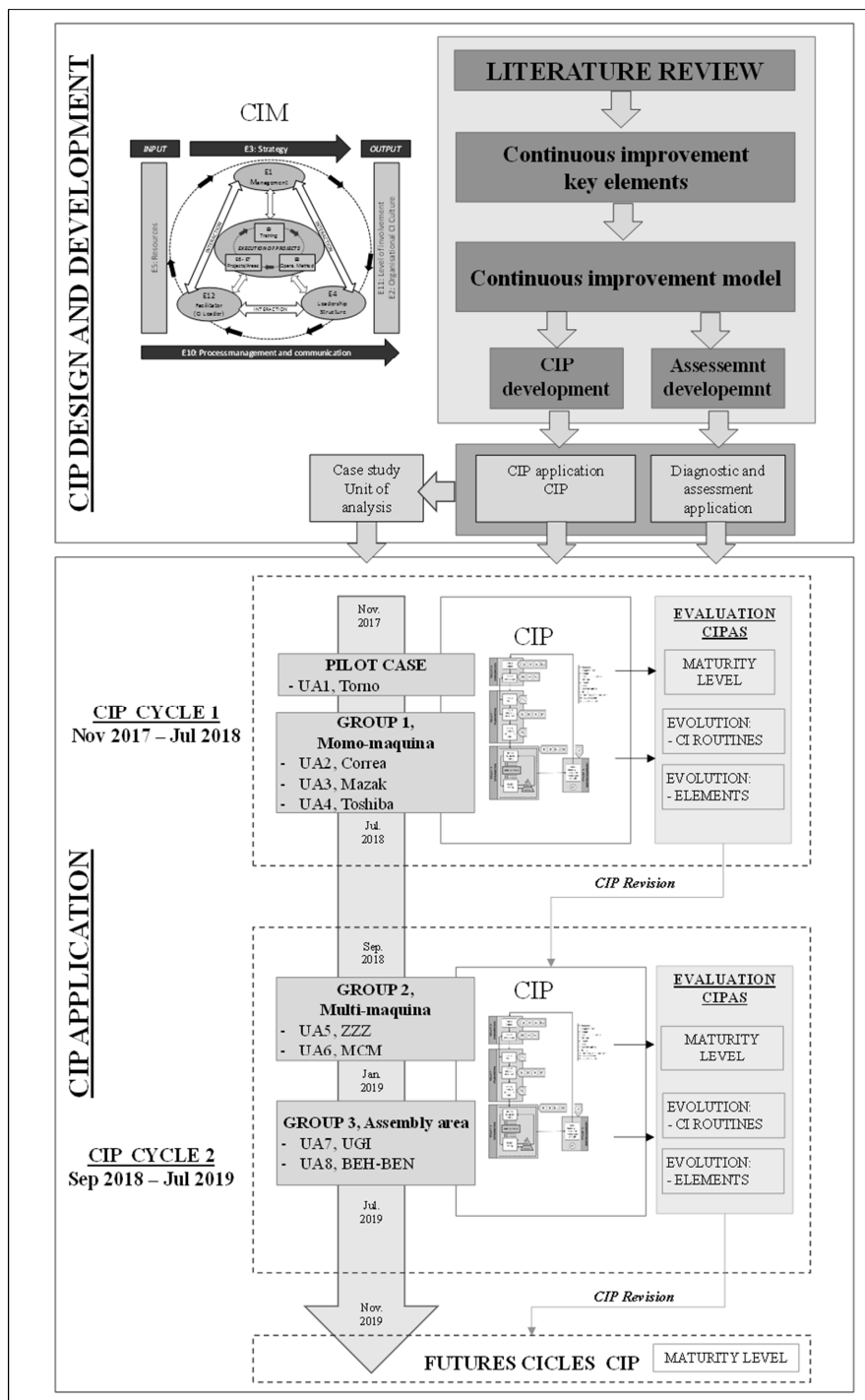

Figure 1 – Research Methodology Steps

Figure 1 shows in detail the deployment of the methodology, it can be seen that a review of the literature was carried out to identify the elements (E). Based on the elements, the CIM was developed (Figure 2), and based on this model, a CIP and an evaluation system (CIPAS) were proposed. The CIP is an annual cyclic process consisting of four stages, as shown in Figure 2. The current paper shows the results of the execution of two cycles from November 2017 to November 2019, in which eight units, which were grouped into three groups, were analysed.

The main objective of this work is to describe the CIPAS developed to evaluate the implementation and evolution of the CIP. The CIP was applied to an industrial SME cooperative in the capital goods sector. The research team worked directly in the company, applying the action research (AR) methodology. The AR cycles coincided with the CIP review and improvement cycles.

3   CONTINUOUS IMPROVEMENT

CI is the planned, organised and systematic process of ongoing, incremental and companywide change in existing practices and aims to improve company performance (Jorgensen, Boer and Laugen, 2006). Numerous studies have identified the elements and critical success factors (CSF) that must be taken into account when successfully applying CI, and most of them coincide with the key elements. However, various studies have highlighted the importance of various elements depending on the focus of the study and its scope of application (large or small and medium enterprises, public or private, etc.). To define the key elements of the model, a study carried out in a similar context (mature industrial companies in the Basque Country) (Egiguren, 2012) was taken into consideration as a reference. This study was developed in a large automotive supply company, while our CS focused on a capital goods sector SME. For this reason, a review of the elements was reinforced with the most recent contributions, as well as reviews published by several authors regarding the CSFs for the sustainability of CIP. The most important elements to develop a CIM and the principal authors are summarised as follows:

E1: Management. The involvement and commitment of the management are necessary (Readman and Bessant, 2007; Garcia-Sabater, Marin-Garcia and Perello-Marin, 2012; Gonzalez Aleu and Van Aken, 2015; Costa et al., 2019; Stankalla, Koval and Chromjakova, 2018).

E2: Company culture. New behaviours and routines must be developed among all members of the organisation (Bateman, 2005; Egiguren, 2012; McLean and Antony, 2017).

E3: Strategy. The CIP must be a strategic element of the operating plan, and the strategic goals and CI project goals must be aligned (Bessant, Caffyn and Gallagher, 2001; Jurburg et al., 2019).

E4: Leadership and structure. The organisation must have a CI organisational structure (Wu and Chen, 2006; Fryer, Ogden and Anthony, 2013; Lodgaard et al., 2016; Stankalla, Koval and Chromjakova, 2018).

E5: Resources. The organisation must make the necessary resources available: economic, time and training (Bateman and Rich, 2003; Wu and Chen, 2006).

E6: Projects and *E7: Areas.* Improvement projects should be clear, realistic and focused on critical areas or processes (Egiguren, 2012; Lodgaard et al., 2016), where the need for improvement should be clearly seen (Bateman and Rich, 2003).

E8: Operating method and improvement tools. It is necessary to adapt the operating method to the situation within each organisation (Bhuiyan and Baghel, 2005; Dale, 2015) to enhance the participation of the people in the CI activities (Jurburg et al., 2019). The tools must align with the maturity of the organisation in terms of CI and production (Wu and Chen, 2006; Kosieradzka and Ciechańska, 2018).

E9: Training. Training should be based on the operating method (Gonzalez Aleu and Van Aken, 2015; McLean and Antony, 2017; Costa et al., 2019) and aligned to improvement projects.

E10: Monitoring and communication. A CIP follow-up process must be established. This should measure two aspects: the effectiveness of the results from the improvement project and the evolution of the CIP (Bessant, Caffyn and Gallagher, 2001; Gonzalez Aleu and Van Aken, 2015).

E11: Level of involvement. The involvement of management and all employees is essential to achieve long-term improvement (Garcia-Sabater, Marin-Garcia and Perello-Marin, 2012; Costa et al., 2019). A systematic process and the application of improvement tools help to involve the participants (Jurburg et al., 2019).

E12: Facilitator (CI leader). The CI leader must take on the role of facilitator, guiding and coaching the promoter and project teams before and during projects (Garcia-Sabater, Marin-Garcia and Perello-Marin, 2012; Heavey, Ledwith and Murphy, 2014; Gonzalez Aleu and Van Aken, 2015). However, until the CI leader acquires the necessary skills, the facilitator can be a person outside the organisation.

CI refers not only to the outcomes, but also to the process by which these can be achieved (Bessant, Caffyn and Gallagher, 2001). Bessant, Caffyn and Gallagher (2001) proposed an evolutionary CI maturity model that is divided into five levels, in which organisations can be placed according to the maturity of the organisation in terms of CI. The evolutionary model promotes the development of an organisational culture that enables the organisation to move towards excellence in CI by adopting eight routines at the organisational level, R1 'understanding CI', R2 'getting the CI habit', R3 'leading the way', R4 'focusing

CI', R5 'aligning CI', R6 'shared problem solving', R7 'CI of CI' and R8 'the learning organisation'. To progress between the levels, the organisation must consolidate and assume as the natural course of operations the routines generated while still creating new routines that take the organisation to the next level. Table 1 shows the description of each maturity level.

3.1   Continuous Improvement Model

The relation of the selected elements to each other was defined to create the CIM. As shown in Figure 2, the execution of projects is the central point of the model. The selected operative method (E8), training (E9) and projects and areas (E6, E7) are necessary 'tools' to develop the activities that generate the CI routines. To use these 'tools' correctly, it is necessary to have the support of the management (E1), to have a defined CI organisational structure (E4) including a CI leader as a facilitator (E12). The management, the CI leader and the defined CI structure are responsible for defining a strategy to deploy the CIM, correctly manage the resources and control the CIP and each project to ensure the involvement of people and develop a CI organisational culture.

According to Bessant, Caffyn and Gallagher (2001), the assimilation and evolution of the eight improvement routines increases the maturity level of the organisation. Fryer, Ogden and Anthony (2013), in the same line, stated that the evolution of several key elements to develop CI also increases the level of maturity. The development and evolution of CI routines and the evolution of CI maturity demonstrate the constant development of a CI organisational culture (Bessant and Caffyn, 1997; Bessant, Caffyn and Gallagher, 2001).

3.2   Continuous Improvement Process

To create and assimilate new CI routines, it is necessary to apply improvement tools and methods through a systematic and structured process. CIP refers to the process for carrying out the CIM and was configured in four stages. The phases to be executed in each stage were identified, along with the elements that exert a significant influence in each stage (Figure 2). CIP is a process that repeats itself cyclically with a certain periodicity. In the CS, the determined period is annual. The improvement stage (Stage 3) serves as an input for the diagnosis of the next cycle.
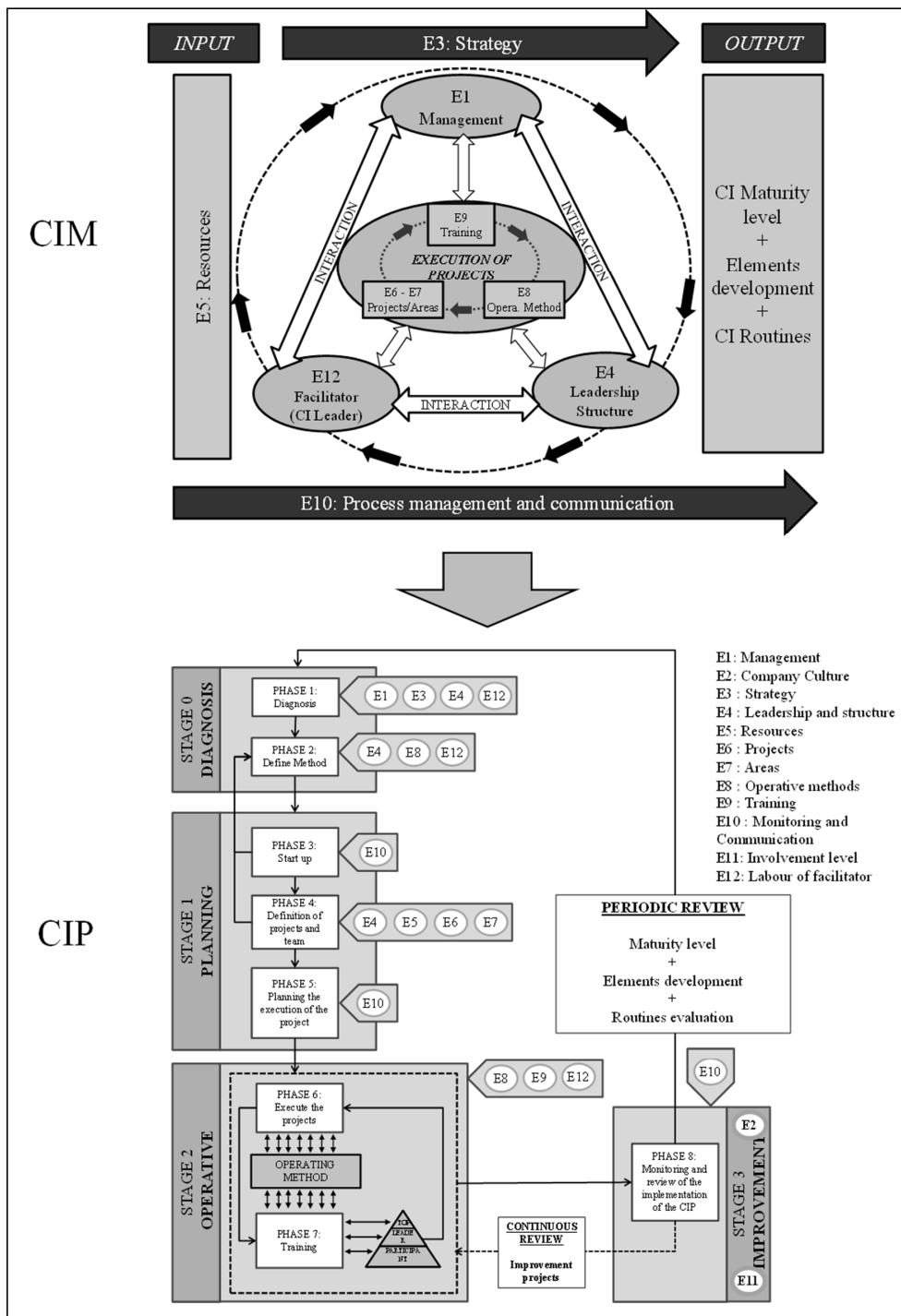
Figure 2 – CIM and CIP

3.2.1   STAGE 0: Diagnosis

The management must make the diagnosis and select the appropriate operating method to develop the CI system. The diagnostic stage was divided into two phases: diagnosis (phase 1) and definition of the operating method (phase 2).

Phase 1 (diagnosis) was based on the evaluation of the CI maturity level of the organisation. The maturity was measured using a questionnaire (presented in Appendix, Table A1), where in each level, the respondent have to answer 'true' or 'false' for several statements. Each level have ten items, and depending the number of 'trues', it is possible to identify the CI maturity status. The design of the questionnaire ensures that responding as 'true' to the items of a level is not possible if most of the items of the lower level have not been answered as 'true'.

In *Phase 2* (define method), while considering the CI maturity, production maturity levels (Kosieradzka and Ciechańska, 2018) and improvement tools used previously, among other things, management must identify the appropriate operating method. Table 1 summarises the principal tools and methods applied at each level.

Table 1 – Methods and Tools Used for Each Maturity Level (Source: Based on Bessant, Caffyn and Gallagher (2001), Kosieradzka and Ciechańska (2018))

	CI maturity level	**Production maturity level**	**Methods and tools used at a given level**
Level 1	*Pre-CI:* • Interest in the concept of CI. Nevertheless, implementation is on an ad hoc basis. No formal efforts or structure for improving the organisation.	*Performed production processes:* • Processes are not iterative or predictable. Impossible to control progress.	• Using employees' tacit knowledge • General control
Level 2	*Structured CI:* • There is a formal commitment to building a CI system. CI initiatives have been introduced.	*Manage production processes:* • Targets are met as a result of implementing a plan. Progress is monitored.	• 5S • Standard operating procedures • Autonomous maintenance • Provisioning Kanban • Quality goals and standards • Seven quality tools • OEE • Training plan
Level 3	*Goal-oriented CI:* • Commitment to linking CI behaviours to the strategic concerns of the organisation. Formal deployment of strategic goals. Monitoring and	*Defined production processes:* • Targets are met in processes defined in line with the process–approach parameters.	• Production and supply process maps • Value stream mapping (VSM) • Waste identification and elimination

	CI maturity level	Production maturity level	Methods and tools used at a given level
	measuring CI against these goals. CI activities are part of the main business activities. Most of the staff participate in CI activities.		• Work station layout adjusted to the process requirements • Collecting data on quality • Maintenance system (TPM, RCM) • Kaizen events (Blitz)
Level 4	*Proactive CI:* • There is an attempt to devolve autonomy and to empower individuals and groups to manage and direct their own processes. High level of experimentation.	*Quantitatively managed production processes:* • Quantitative and qualitative targets and performance control tools defined for processes and operations.	• Quality and productivity measures established • SPC identification of special causes • DMAIC (Six Sigma) • SMED • Production Kanban • Presentation of productivity and quality performance
Level 5	*Full CI capability:* • Approximates to a framework of a 'learning organisation'. Extensive learning behaviours, systematic finding and solving of problems and capturing and sharing of learning.	*Optimised production processes:* • Processes are continuously improved and adapted to the changing environment and corporate strategy.	• Process re-engineering • Kaizen in the whole organisation • SPC identification of common causes • DMAIC (Six Sigma) • Teamwork, culture of 0 defects, 0 equipment failure, 0 time waste

Stage 0 (diagnosis) ensured that the proposed operational methods and projects were aligned with the organisation's strategy and focused on the customer (external and internal).

In the CS, after regular meetings between the research team and top management to analyse the organisation's situation and after using the maturity level questionnaire to develop the interviews, the first diagnosis found that the organisation was at level 1. The company did not have an organisational structure to develop CI, the company did not have a defined CI leader, problems were solved as they arose using an employee's tacit knowledge without a strategy to deploy CI activities, the proposed solutions had a short path, and generally, management and employees were not concerned about CI activities. The studied company set itself the target of surpassing maturity level 2 within a period of two years. To this end, the research team together with the management defined a strategy to deploy the system, proposed defining an organisational structure with responsibilities related to improvement activities, apply an operating method to define the bases of the CI system and train employees and middle management in basic improvement tools.

The improvement tool selected to start defining the basis for CI was 5S. The 5S methodology is a lean tool developed by Japanese manufacturing companies comprising five stages: sort (*seiri*), set in order (*seiton*), shine (*seiso*), standardise (*seikats*u) and sustain (*shitsuke*) (Khan et al., 2019). The methodology is simple to apply, facilitates the participation of employees in the area and promotes teamwork. Many authors have pointed to 5S as a suitable tool for this purpose (Randhawa and Ahuja, 2017; Khan et al., 2019).

3.2.2 STAGE 1: Planning

In the planning stage, after identifying the signs and behaviours that ensure the support of those responsible (department managers) for the various areas within the organisation – which was done through specific training – the chosen operative method was adapted to the reality of the organisation. In addition, the channels and activities that facilitate communicating the characteristics and benefits of the CIP to all personnel were developed (Gonzalez and Martins, 2016; Stankalla, Koval and Chromjakova, 2018). Finally, the planning of each project was developed.

3.2.3 STAGE 2: Operative

In the operative stage, two phases were developed in parallel: the execution of the projects and the training of the participants. Execution was developed according to the project plan, and training was adapted to the operative method and the various organisational structure levels (see Table).

Table 2 – Developed Training Summary

Level	Participants	Content	STAGE
Top management	• Chief executive officer • Industrial director • Quality director	• Awareness talk about CI • General structure CIM, CIP • General planning	STAGE 0
Middle management	• Quality director (management representative as a CI leader) • Several department managers: production, planning, process engineering, quality, etc.	• Awareness talk about CI • CI levels, CIM, CIP • General planning • Brief training on the selected methodology (5S)	STAGE 1
Project team members	• Quality director (CI leader) • Project leaders • Project team members	• Formal training on selected method in depth: awareness and technical (5S)	STAGE 2

3.2.4 STAGE 3: Improvement

Organisations should analyse CI activity periodically to understand its weaknesses and implement corrections. Self-examination is the most effective way to achieve successful CI (Jorgensen, Boer and Laugen, 2006; Wu and Chen,

2006). As Wu and Chen (2006) suggested, the evaluation system and specific metrics used should be adapted to each CI level. Although the general evaluation system's structure can be the same, depending on the CI maturity level and the operative method applied, the metrics that are used can change. The CIPAS was developed according to these principles.

4 CONTINUOUS IMPROVEMENT PROCESS ASSESSMENT SYSTEM

The objective of the CIPAS is to analyse the evolution of CI organisational culture development, based on the evolution of the maturity level of CI, the assimilation and evolution of the CI routines and the evolution of the CIM key elements over time. The CIPAS measures three main aspects:

- CI maturity level
- CI routines development and assimilation
- CIM key elements development

4.1 CI Maturity Level

The maturity level was measured at the beginning of each CIP cycle. The assessment of the maturity level was based on a questionnaire (Appendix, Table A1) that must be completed by the promoter team, which was led by the CI leader, at the beginning of each cycle.

4.2 Evaluation of CI routines

According to Bessant, Caffyn and Gallagher (2001), to move up maturity levels, it is necessary to assimilate CI routines through the acquisition of skills and behaviours related to these routines. The evolution of these routines was evaluated using a questionnaire (Appendix, Table A3) that is based on the 'constituent behaviours', as defined by Bessant, for each of the routines (Bessant, Caffyn and Gallagher, 2001). The promoter team led by the CI leader must complete the questionnaire at the end of each CIP cycle.

4.3 Evaluation of CIM Key Elements

To evaluate the key elements of the CIM, two strategies were defined. First, the elements that must be kept constant during CIP implementation were defined. To measure the evolution of the other elements, indicators were defined for each of them.

Elements to keep constant: At the beginning of CIP implementation, several rules were defined to keep these elements constant.

Table 3 shows these elements, their description, why they should be kept constant and the rules defined to keep them constant. This reflection is necessary in each CIP cycle.

Valued elements: These elements were valued by means of indicators. The CI leader, the project leaders and the research team collected the information through direct observation and a survey completed by the employees. Three types of elements were evaluated: XV: Elements assessed in which the research team did not act directly, but which influenced their development; XA: Elements in which the research team acted directly for their correct development; Y: Output elements, resulting from the development of input elements XV and XA. Table 4 shows the valued elements, their description and the corresponding metrics of each element.

Table 3 – Elements that Must be kept Constant

Elements to observe	Description	Why do you want to keep constant	Guidelines followed to keep constant
E1:Management E3: Strategy	The CIP must be under the responsibility of the management. The organisation must deploy the CIP with a strategic vision, must select the operating method, and must find the areas and projects that will respond to the strategic objectives. The management must keep the activities aligned with the strategic objectives of the organisation.	Changes in strategy or management's vision during CIP implementation can confuse the team and employees and hinder implementation.	First, meetings with the management to define the strategic vision, the objectives to be achieved and the strategy for the deployment of the CIP. Establish project and CIP monitoring guidelines. Training meetings with management to carry out the diagnosis and establish the operational method to be applied. Participation of a management representative in follow-up and communication meetings.
E10: Follow-up and communication	The CIP is a process of change through the modification and establishment of routines and behaviours. Therefore, it is necessary to have a monitoring and communication system.	Changes in the monitoring (follow-up) system during CIP implementation can confuse the team and employees and be a barrier to their participation.	Rules to follow up were established to evaluate the improvement projects launched. Transparent and common communication channels were established for all projects.

Table 4 – Elements to Measure Its Evolution

Element Valued	Description	Metrics
E4: Leadership and strategy	Organisational structure developed for the CI, divided into three levels (Management, promoter team, and project teams). Leadership is divided into two levels – management and project leaders – and each type of leadership has its responsibilities.	**XV-E4-1:** Nº of changes in the team structure (0%–100%) **XV-E4-2:** Nº of meeting/month **XV-E4-3:** % Attendance at meetings
E5: Resources	Management must display the resources necessary to execute the CIP. Time to execute the improvements, release of the people involved in the CIP and economic resources to address the investments derived from the proposed improvements.	**XV-E5-1:** Hours dedicated to developing project **XV-E5-2:** Hours dedicated to follow up
E6–E7: Projects and areas	Management must select the projects and areas that are the most critical for the organisation. For selection must be considered: • The complexity of the area • The saturation level of the workers • The size of the area	**XV-E67-1:** Complexity of the areas (initial audit of the area) **XV-E67-2:** Operator saturation level **XV-E67-3:** Area size and quantity of means
E8: Operative method	The operating method must be adapted to the organisation. Each project must be managed efficiently, following the defined phases. The operating method must be evaluated by the participants.	**XA-E8-1:** % of phases executed effectively **XA-E8-2:** Score obtained in the survey/maximum possible score
E9: Training	A training plan must be defined. The training must be applied in the real environment (project). The training must be evaluated by the participants (survey).	**XA-E9-1:** % attendance to regulated formations **XA-E9-2:** Score obtained in the survey/maximum possible score
E11: Level of involvement	The leader must devote time (determined beforehand by the promoter team) to the control and follow-up of the project. The motivational work done by the leader must be evaluated by the project team (survey). The number of improvement proposals made by the participants must be gathered. Sensation of the participants applying the improvement methodology must be gathered (survey rating).	**Y-E11-1:** Hours dedicated to follow up/month **Y-E11-2:** Score obtained in the survey/maximum possible score **Y-E11-3:** Number of suggestions made by the participants of the area/first three months **Y-E11-4:** Score obtained in the survey/maximum possible score

Element Valued	Description	Metrics
E12: Labour of facilitator	The facilitator, as an expert in CI, develops the following functions: • Train the participants of the CI structure (management, leaders, employees). • Track the deployment of the CIP. • Support project leaders in the execution of the operational method and in the development of meetings and presentations. The labour of the facilitator must be evaluated by the participants (survey).	**XA-E12-2:** Score obtained in the survey/maximum possible score

The valuation of the metrics presented in Table 4 are represented in percentages. These percentages were calculated by taking 100% as the reference: the highest value of the item, the highest possible value on the Likert scale that was used in the survey or the level of compliance with the defined standard (e.g., the execution of defined meetings or the level of attendance at meetings).

5   RESULTS

The results of the evaluation confirm that through the implementation and application of the CIP, the organisation increased its CI maturity level. Management, middle management and employees developed several improvement routines that were further deployed and assimilated in the second cycle. Like the CIPAS, the results are divided into three aspects: the evaluation of the maturity level, the evaluation of the CI routines and the evaluation of the key elements of the CIM.

5.1   Maturity Level Evolution

The maturity level was measured three times at the beginning of each cycle. In the first cycle, with the direct support of the research team, management completed the evaluation. This evaluation was carried out after training the management team on issues related to CI. The second and third evaluation was completed by the promoter team, which was led by the CI leader with the support of the research team (Figure 3).

The periodic evaluation shows an increase in the level of maturity of the organisation. The first diagnosis indicated that the organisation was at level 1, with a value of 0.5, which increased as the CIP was deployed, until it surpassed level 2 with a value of 2.2. Among other things, the definition of an organisational structure dedicated to CI (defined specific roles to each participant), the definition of the follow-up rules and the application of an

operational method in a systematic and structured manner justifies this increase in maturity.

5.2   CIM Key Elements Evolution

The CIM key elements were measured at the end of each cycle on two occasions. Figure 3 shows how all elements, except for E12 (facilitator), positively evolved as CIP implementation progressed. After the first cycle, the poorest results were obtained for elements E4 (leadership and structure), E5 (resources), E6–7 (projects and areas) and E11 (involvement). In the second cycle, actions were taken to reinforce these elements. E4 was strengthened by officially introducing the meetings of the promoter team in the calendar of monthly periodic meetings. The CI leader led these meetings, where each project leader reported the evolution of his project. The periodic meetings of the promoter team encouraged the execution of the weekly meetings of the improvement teams. To improve E5, the management, through the promoter team, allocated more time to the implementation of improvement activities, especially to leaders and project participants. The CI leader increased his participation in project follow-up meetings, boosting their execution and ensuring the participation of team members. With the actions proposed, the level of employee involvement (E11) and participation increased, increasing the number of suggestions for improvement.

Through a survey, employees evaluated the work carried out by the facilitator. The principal investigator played the role of external facilitator, decreasing his participation in the second cycle as the CI leader increased his participation and took on the role of feacilitator.

5.3   CI Routines Evolution

On two occasions, the assimilation of routines was measured at the end of each cycle. In the CS, the promoter team led by the CI leader completed the questionnaire presented in Appendix (Table A3), with the support of the research team. Garcia-Sabater, Marin-Garcia and Perello-Marin (2012) structured the necessary routines to be developed at each maturity level. Based on this study, the researchers could quantify, the results, and the necessary level of assimilation of each routine for 2nd maturity level are shown in Figure 3.

As can be seen in Figure 3, the assimilation of routines evolved positively although in all routines, the objective set for maturity level 2 was not achieved. The company should continue to work to encourage employee participation in CI by applying new improvement tools. In areas where suggestion management systems, manufacturing process measurement and improvement activities or the supply Kanban method was implemented, the results of the 'getting the CI habit' and 'leading the way' routines were better. It is also necessary to focus on CI by aligning projects with the organisation's strategic goals. During the first two cycles, the projects were oriented towards the definition of operating standards

and the standardisation of workplaces rather than towards the improvement of critical processes that can be focused on by achieving specific strategic objectives. Once the improvement dynamics were established during the first two cycles, in the following cycle, the improvement teams created were multidisciplinary, involving employees at different organisational levels, with the aim of developing more specific projects (changing layouts, improving manufacturing processes, developing self-control in critical processes, etc.). The execution of these new projects allows for the development of the 'shared problem solving' and 'focusing CI' routines.

However, Jorgensen, Boer and Laugen (2006) declared that the maturity model does not have to follow a linear progression. The results of the present CS support this affirmation. As can be seen in Figure 3 there are routines, such as 'aligning CI' and 'CI of CI' -which in theory correspond to higher maturity levels- that are more assimilated than others like 'CI focusing'.
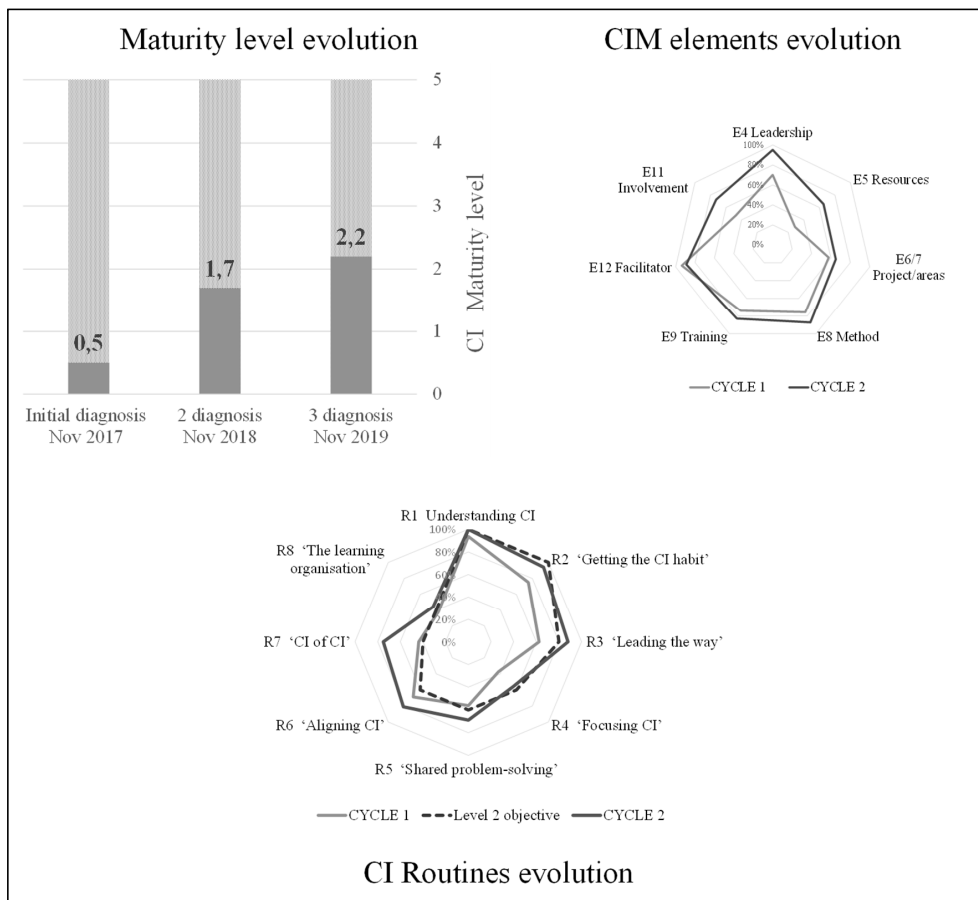

Figure 3 – Maturity Level, CIM Key Elements and CI Routines Evolution

6 CONCLUSION

The current field research shows that the improvement process (CIP) that was developed and implemented helped develop improvement routines, advance the CI maturity level and develop the basis of an organisational CI culture. The CIP served to meet the objective set by the research team and management, overcoming level 2 of CI maturity. The application of the CIP allowed for acquiring and assimilating improvement routines and reinforcing the key elements of the CIM. In the first two cycles, the bases of the CI system were established. An organisational structure adapted to the organisation itself was defined, based on a promoter team and led by a CI leader. During the first cycle, the roles and rules of the team's operations were established, and in the second cycle, the team members assimilated the roles and rules. Reinforcing the teamwork and involvement of the promoter team made it possible to define and launch new projects (self-control system, advanced product quality planning (APQP), picking logistics systems and automated storage, etc.) and create improvement teams to respond to the problems identified in the evaluation and diagnosis. To articulate the relations between the promoter team and the improvement teams, the participation of management through the CI leader was key.

On the other hand, the proposed measurement system (CIPAS) served to measure the evolution of the CIM that was implemented in the organisation. The CIPAS made it possible to assess the organisation's level of maturity on the Bessant scale, to assess the evolution of improvement routines and to identify the key elements of the CIM that needed to be improved in each cycle. In addition, the CIPAS facilitated the identification of activities that reinforced the maturity of the organisation. The diagnostic and evaluation tools facilitated the visualisation of the progress of the CI system in a visual way. The greatest challenge in implementing the CIPAS was to make management, especially the promoter team, realise that to advance in CI maturity levels, it is necessary to measure the evolution of the CIP. To this end, it was necessary to work with the promoter team on the design of the CIPAS and to demonstrate that based on the evaluations, they were able to propose actions to improve CIP itself, in addition to launching new improvement projects.

In light of the findings, future research in the organisation should be conducted to discover what key elements of CI are still lacking or should be strengthened in higher maturity levels.

Regarding limitations, even if it is only an organization-specific implementation and is not possible to generalize the results, the step-by-step approach of the case study can be a reference to applied to other organisations. The developed questionnaires provide a practical approach to assess the maturity level and to check the development of the organization's routines. In addition, the CIP and the CIPAS can be used as a theoretical basis to adapt the CIM, and apply these in another type of organisations that use other business models.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

APPENDIX

Each statement must be evaluated as a "true" or "false".

Table A1 – Maturity Level Questionnaire (1)

MATURITY LEVEL
LEVEL1
1. Problems are resolved as they arise (randomly).
2. Departmental teams are created to solve specific problems.
3. There is organisational structure to develop the CI.
4. There is a CI leader.
5. Improvement projects are occasional (a system exists to 'look for problems').
6. Employees participate in improvement projects.
7. The solutions posed to the problems are middle to long term.
8. There is a structured system to manage improvement suggestions.
9. The solutions implemented have an impact on the strategy.
10. There is a recognition system (economic, promotion, etc.).
LEVEL 2
1. There is an organisational structure for the CI and a CI leader (partial of full availability).
2. Improvement teams are created to solve specific problems.
3. There is a CI process, and it is applied.
4. There are process improvement teams.
5. Teams apply improvement tools (troubleshooting).
6. Employees have been trained in basic tools for improvement and problem solving (5S, seven quality basics tools).
7. 50% or more employees participate in CI activities.
8. There is an idea management system (suggestions box, improvement meetings, improvement suggestions analysis, etc.).
9. There is a recognition system (economic, promotion, etc.).
10. CI activities are part of the daily (operational) activities of the organisation.
LEVEL 3
1. The strategic objectives are deployed at all levels of the organisation in a formal way.
2. The improvement projects are monitored against the strategic objectives deployed.
3. There is a CI leader with total availability to exercise his role.
4. There is a coordinated system to launch new improvement teams.
5. 75% or more employees participate in CI activities.

MATURITY LEVEL
6. CI activities are an important part of the daily (operational) activities of the organisation.
7. The CI system includes interdepartmental (interfunctional) improvement teams.
8. The CI teams include personnel from different organisational levels (employees, middle managers, department managers, etc.).
9. CI teams include personnel from other organisations (client, supplier).
10. Improvement projects have a focus on solving interdepartmental problems (global vision, not departmental).
LEVEL 4
1. The strategic objectives are deployed at all levels of the organisation in a formal way.
2. The improvement projects are monitored against the strategic objectives deployed.
3. The CI leader (full time) and the CI organisational structure are seated and exercise their role (search for improvement opportunities).
4. Improvement teams are autonomous and can define problems, establish specific objectives and plan their actions.
5. More than 75% of employees participate in CI activities.
6. CI activities are part of the main activities of the organisation.
7. The improvement teams are interdepartmental and include personnel from different organisational levels (employees, middle managers, department managers).
8. CI teams include personnel from other organisations (client, supplier, etc.).
9. Improvement projects have a focus on solving interdepartmental problems (global vision, not departmental).
10. The level of experimentation (test of different solutions) is high.
LEVEL 5
1. The strategic objectives are deployed at all levels of the organisation in a formal manner, and the projects respond to these objectives.
2. The CI leader and the members of the promoter team have a total availability to exercise their role (search for opportunities, coordination of improvement projects, etc.).
3. The promoter team tracks the improvement projects, ensuring that they respond to the strategic objectives.
4. There is a system to capture learning and share new knowledge (the CI leader and the promoter team play this role).
5. The promoter team and improvement teams constantly identify the need for learning at all levels of the organisation.
6. Improvement teams are autonomous and can define problems, establish specific objectives and plan their actions.
7. More than 75% of employees participate in CI activities.
8. The improvement teams are interdepartmental and include personnel from different organisational levels and include other organisations (Customer supplier).
9. Improvement teams apply a system to find and solve problems.
10. Experimentation is widespread and autonomous but controlled by management (through an organisational structure).

Depending on the number of 'true' answers obtained, the maturity level of the CI can be defined.

$$CI\ maturity\ level = \frac{number\ of\ 'true'\ answers}{10} \qquad (1)$$

Table A2 – Number of 'True' Answers

LEVEL	Number of 'true' answers
LEVEL 1	0 – 10
LEVEL 2	11 – 20
LEVEL 3	21 – 30
LEVEL 4	31 – 40
LEVEL 5	41 - 50

The routines evolution questionnaire has been developed based on constituent behaviours as defined by Bessant, Caffyn and Gallagher (2001). Each statement must be evaluated on a Likert-type scale ranging from 1 (disagree) to 4 (strongly agree).

Table A3 – Routines Evolution Questionnaire (2)

Routines evolution		Likert
R1 Understanding CI' - the ability to articulate the that basic values of CI		
1. People at all levels demonstrate a shared belief in the value of small steps, and everyone can contribute by being actively involved in making and recognising incremental improvements.	Are people involved in developing and implementing small improvements in their jobs?	-
2. When something goes wrong, the natural reaction of people at all levels is to look for reasons why rather than to blame individual(s).	Faced with problems, are solutions sought before the guilty?	-
3. People make use of some formal problem finding and solving cycle.	Are problems and solutions discussed in appropriate discussion forums using troubleshooting tools?	-
R2 'Getting the CI habit' - the ability to generate sustained involvement in CI		
4. People use appropriate tools and techniques to support CI.	Are appropriate techniques and tools used to solve the problems?	-
5. People use measurement to shape the improvement process.	Are measured the improvements made?	-
6. People (as individuals and/or groups) initiate and carry through CI activities – they participate in the process.	Do workers propose improvements? Do workers participate in CI activities?	-
7. Closing the loop – ideas are responded to in a clearly defined and timely fashion and are either implemented or otherwise dealt with.	Are management members (leaders) adequately responding to improvement suggestions?	-

Routines evolution		Likert
R3 *'Leading the way' - the ability to lead, direct and other support the creation and sustaining of CI behaviours*		
8. Managers support the CI process through allocation of time, money, space and other resources.	Are continuous improvement activities supported with necessary resources (time, economical, education, training, etc.)?	-
9. Managers recognise in formal (but not necessarily financial) ways the contribution of employees to CI.	Is the contribution of workers making improvements or suggestions for improvement formally recognised?	-
10. Managers lead by example, becoming actively involved in the design and implementation of CI.	Do the leaders lead the improvement activities to set an example?	-
11. Managers support experiment by not punishing mistakes but by encouraging learning from them.	Do managers (leaders) encourage employees to experiment (without penalising the error) to find the right solutions?	-
R4 *'Focusing CI' - the ability to link CI activities to the strategic goals of the company*		
12. Individuals and groups use the organisation's strategic goals and objectives to focus and prioritise improvements, and everyone understands (i.e., is able to explain) what the company's or department's strategy, goals and objectives are.	Does the company present the strategic objectives in a clear and general way? Do workers know what the company's objectives are?	-
13. Individuals and groups (e.g., departments, CI teams) assess their proposed changes (before embarking on initial investigation and before implementing a solution) against departmental or company objectives to ensure they are consistent with them.	Do workers evaluate/contrast their suggestions for improvement against the company's objectives?	-
14. Individuals and groups monitor/measure the results of their improvement activity and the impact it has on strategic or departmental objectives.	Are the results of the improvements made measured and their impact on the company's objectives contrasted?	-
15. CI activities are an integral part of the individual or groups work, not a parallel activity.	Are MC activities part of daily work? Or are they an extra job?	-
R5 *'Shared problem-solving' - the ability to move CI activity across organisational boundaries*		
16. People co-operate across internal divisions (e.g., cross-functional groups) in CI, as well as working in their own areas.	Are there multidisciplinary teams to execute the CI activities?	-
17. People understand and share a holistic view (process understanding and ownership).	Do workers have a global vision of the CI system?	-
18. People are oriented towards internal and external customers in their CI activity.	Is the CI system customer oriented (internal/external)?	-
19. Specific CI projects with outside agencies (customers, suppliers, etc.) are taking place.	Are CI projects developed with agents outside the organisation?	-
20. Relevant CI activities involve representatives from different organisational levels.	Do CI activities involve workers of different organisational levels?	-

Routines evolution		Likert
R6 *'Aligning CI' - the ability to create consistency between CI values and behaviour and the organisational context (structures, procedures, etc.)*		
21. Ongoing assessment ensures that the organisation's structure and infrastructure and the CI system consistently support and reinforce each other.	Is there an organisational structure that supports the CI activities?	-
22. The individual/group responsible for designing the CI system design it to fit within the current structure and infrastructure.	Does the organisational structure of the CI conform to the current organisational structure?	-
23. Individuals with responsibility for particular company processes/systems hold ongoing reviews to assess whether these processes/systems and the CI system remain compatible.	Are the company's processes compatible with the CI system?	-
24. People with responsibility for the CI system ensure that when a major organisational change is planned, its potential impact on the CI system is assessed and adjustments are made as necessary.	When there are changes in the organisation, is it analysed if the changes affect the CI system/structure?	-
R7 *'Continuous improvement of continuous improvement' - the ability to strategically manage the development of CI*		
25. The CI system is continually monitored and developed; a designated individual or group monitors the CI system and measures the incidence (i.e., frequency and location) of CI activity and the results of CI activity.	Is the continuous monitoring of the CI system and the results of the CI activities?	-
26. There is a cyclical planning process whereby (a) the CI system is regularly reviewed and, if necessary, amended (single-loop learning).	Is the CI system reviewed regularly (annual frequency) and modified if necessary?	-
27. There is periodic review of the CI system in relation to the organisation as a whole, which may lead to a major regeneration (double-loop learning).	Is the CI system reviewed and its relationship with the organisation (analysing if there are changes in the organisation itself), and is it adapted if necessary?	-
28. Senior management makes available sufficient resources (time, money, personnel) to support the ongoing development of the CI system.	Does the management support and give the necessary resources (time, people, money) to develop the CI system?	-
R8 *'The learning organisation' - generating the ability to enable learning to take place and be captured at all levels*		
29. People learn from their experiences, both positive and negative.	Do workers learn from their experiences (positive or negative)?	-
30. Individuals seek out opportunities for learning/personal development (e.g., actively all levels experiment, set their own learning objectives).	Do people look for opportunities to learn and develop personally?	-
31. Individuals and groups share (make available) their learning from all work experiences.	Do workers share their knowledge with others naturally?	-

Routines evolution		Likert
R8 *'The learning organisation' - generating the ability to enable learning to take place and be captured at all levels*		
32. The organisation articulates and consolidates (captures and shares) the learning of individuals and groups.	Are there internal training plans to socialise knowledge?	-
33. Managers accept and, where necessary, act on all the learning that takes place.	Does management accept the training developed? Does management participate in the trainings?	-
34. People and teams ensure that their learning is captured by making use of the mechanisms provided for doing so.	Do workers ensure that their knowledge is documented?	-
35. Designated individual(s) use organisational mechanisms to deploy the learning captured across the organisation.	Are there mechanisms in the organisation to share knowledge across the organisation?	-