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Continuous Improvement process model: A Knowledge Management approach

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***Résumé* – Le contexte en constante évolution et les défis qu'il représente, amènent les entreprises à la nécessité d'améliorer leur performance de façon permanente. Depuis ses origines et à un rythme d'adoption croissant, l'amélioration continue (vue sous les différentes méthodologies comme le Lean Manufacturing, le Lean Six Sigma, etc.) a joué un rôle important, car sa mise en œuvre est considérée comme un moyen d'améliorer le niveau de performance et les processus. Néanmoins, et malgré les nombreuses études développées, il y a un grand nombre d'échecs sur ces mises en œuvre. Les études actuelles se sont surtout concentrées sur l'identification des facteurs d'échec ou de succès, mais la clarification du processus organisationnel reste inexplorée et mal comprise. En conséquence, suivant la méthode MASK et le méta-modèle KROM, cette étude propose un modèle de processus de l'amélioration continue en mettant en évidence les objectifs, les missions et les cinq processus clés. Ceci est réalisé en capitalisant les connaissances issues des entretiens avec 5 experts sur l'amélioration continue provenant d'entreprises multinationales.**

***Abstract* – The current changing context and challenges it poses, bring companies to the need to improve their performance in a continuous way. For this means, since its origins and at an increasing adoption rate, the Continuous Improvement (seen under the different methodologies like, Lean Manufacturing, Lean Six Sigma, etc.) has played an important role, as its implementation is understood to lead to a better performance level and improved processes. Nevertheless, and despite the numerous developed studies, there is being seen a high number of failures on these implementations. Current studies have been focused mostly on the identification of failure or success factors, but the clarification of the organizational process remains unexplored and misunderstood. Accordingly, following MASK method and KROM meta-modelling, this study proposes a continuous improvement process model evidencing the goals, missions and the five key processes. This is done by capitalizing the knowledge from the interviews with 5 experts on Continuous Improvement from multinational companies.**

***Mots clés* – Amélioration Continue, Amélioration de la performance, Gestion des connaissances, Modélisation des processus.**
***Keywords* – Continuous Improvement, Performance Improvement, Knowledge Management, Process modelling, Knowledge Capitalization.**

1 INTRODUCTION

Nowadays, companies are seeking to constantly improve their level of performance. Thus, the Continuous Improvement of the performance in an organization plays a fundamental role. Continuous Improvement has been known over the years as an approach with the main purpose of enhancing the performance in an organization or their processes [Bond, 1999; Gonzalez Aleu & Van Aken, 2016]. It has been widely popularized and implemented through various methodologies, among those, the most important and well-known are Lean Manufacturing, Lean Six Sigma and Six Sigma [Gutierrez-Gutierrez and Antony, 2019; McLean et al., 2017; Message Costa et al., 2018].

It is found in the literature that the widespread adoption of the Continuous Improvement approach not only leads to a better performance level, but it also contributes to the innovation of the organization. And that it is in fact through its implementation that is possible for a firm to promote a culture that responds to the challenges and changes in the context for enduring its sustainability [Hyland et al., 2007]. This extensive interest, its well-known popularity and widespread implementation is said to be highly motivated by the changes in the business environment, which constantly forces companies to keep on improving their performance in order to remain competitive and be able to fulfill customer demands [Khan et al., 2019; Singh & Singh, 2013].

With no doubt, the Continuous Improvement plays a critical and strategic role for the organizations. Nonetheless, there is not much clarity in the literature on the process. Its management is frequently misunderstood, which mainly starts with the blurry use of the term, because it is both used for the complete process, but also refers to just the outcomes of that process [Bessant et al., 2001]. Also, even though the great interest in research on continuous improvement and the widely disseminated promised benefits, what has been appreciated lately is that there is still a lot of gaps to be filled, gaps that are leading to a high percentage of companies that fail in the implementation of continuous

improvement, and thus a great amount of resources are being wasted [McLean et al., 2017; Sanchez-Ruiz et al., 2020].

In the literature we observe that the reasons for failure are the lack of knowledge on Continuous Improvement, lack of an appropriate measurement and follow up system [Sanchez-Ruiz et al., 2020], and lack of alignment with the strategy of the companies [Middel et al., 2007]. Very valuable studies as the two previously mentioned, have been focused on evidencing or identifying the failure or success factor on continuous improvement implementation, but leaving aside the clarification of its whole process. Which is indeed, of mayor importance, as having a formal and well-established process is critical for successful implementation of improvements [Middel et al., 2007]. Thus, it becomes highly relevant to analyze the process of continuous improvement, but not only from the perspective of the execution of projects or outcomes of the process, as it has been mainly analyzed in studies as the ones from Tennant et al. [2002] and Unzueta et al. [2020], but rather to consider the whole complete process in organizations, which has been poorly researched.

Therefore, in order to have a better management of the Continuous Improvement and consequently, helping in reducing the failure rates of implementations, there is still the lack of an overarching vision of this process in the industry. One that is not only focused on isolated solutions or actions, but that allows to understand the process in a comprehensive manner. Thus, the scientific question that arises is: how to model the process of Continuous Improvement of the performance in the organizations? as this is not clear in the literature. Consequently, the aim of this study is to propose a unified model of this process, through MASK, a Knowledge Management approach based on the capitalization of experts' knowledge [Ermine, 2013]. From which the identification of five principal processes of the continuous improvement is done. For doing so, the next section reviews the concepts of Continuous Improvement and Knowledge Management. Then, the methodology for this study is explained in the third section. Followed by the results and discussion in the fourth section. And finally, in the fifth section the conclusions are shown.

2 BACKGROUND

2.1 Continuous Improvement

From its beginnings, Continuous Improvement has been seen as a key element in the performance improvement, constantly increasing its adoption rate [Hyland et al., 2007]. According to the literature, Continuous Improvement was originated in Japan after the Second World War, was then when it was started to be used as an approach and philosophy for performance improvement and not only as isolated initiatives. Becoming then, one of the foundations of the success of the Japanese manufacturing [Singh and Singh, 2015]. As highlighted by [Sanchez and Blanco, 2014], some of the first definitions of Continuous improvement date from 1982 and 1989 by authors Deming and Imai, respectively. From which, it is highlighted its iterative characteristic and the involvement of the different levels at the organization.

The concept has been evolving along with the changes in the environment, it has been constantly ratifying its great importance for organizations. Being seen as an umbrella term and as a necessity for organizations in order to have a better organizational performance, to remain competitive in the market and to adapt to the new context [Khan et al., 2019; Singh and Singh, 2013]. It is certainly a process in which a key factor is the knowledge and involvement of the entire organization [McLean et al., 2017; Singh and Singh, 2015].

Despite this, continuous improvement is a subject that still needs further research and to be analyzed in a more complete way. In this sense, there are studies, like the one from [Almaiman and McLaughlin, 2018], who identifies the cultural aspects that facilitate Continuous Improvement, while stating its importance for achieving the desired benefits. Also, the one from [Heavey et al., 2014] that proposes a framework for continuous improvement by determining its key forces for improving customer value. And finally, the one from [Berger, 1997] who evidences the core principles that are the basis of the Continuous Improvement. Even with the importance and relevance of those studies, there is still lacking a clarification on what is the process of Continuous Improvement.

2.2 Knowledge Management

Knowledge Management has been largely studied, having over the last two decades a noticeable increase of interest from academic researchers as well as from practitioners [Lee and Chen, 2012; Sarka et al., 2019]. it is being understood as mechanisms and processes through which is enabled the creation, sharing and re-utilization of knowledge [Amaral et al., 2016; Bolis et al., 2012; Mårtensson, 2000; Poage, 2003]. Being thus, strategic in the era of the knowledge economy, and aiming at creating value, developing intangible resources, and improving the competitiveness in organizations [Patil and Kant, 2014].

The theory states that knowledge is created through the social interaction of individuals and organizations, and this creation process involves the interaction of two types of knowledge, the tacit and the explicit one, hence enabling a continuous process of knowledge creation [Nonaka et al., 2000]. This process involves four modes of knowledge creation, which are, socialization, externalization, combination, and internalization. It expresses the knowledge creation or crystallization as a never-ending spiral that starts with the individual tacit knowledge level that is subsequently being externalized, transformed into explicit knowledge and then shared among the organization, for ultimately being internalized by individuals, providing a greater understanding and then generating more tacit knowledge [Nonaka and von Krogh, 2009].

Knowledge management builds up on the theory stated by Nonaka and Takeuchi [1995]. It is in fact a strategic approach that supports the knowledge creation process [Matta et al., 2001], which is focused on analyzing the organization knowledge as a resource, and with the main objectives of knowledge capitalization (valorize the knowledge and preserve it), sharing (not only the knowledge circulation, but to reach a collective intelligence) and creation (linked to the permanent innovation of organizations) [Ermine and La, 2003].

This process for knowledge capitalization, the externalization from tacit knowledge of the experts to explicit one, can be either done by an approach of only knowledge transcriptions, or under a knowledge engineering approach, which in the literature is considered to be even more complete and robust [Ermine and La, 2003]. Among the different methods of knowledge engineering, MASK (Method for Analysis and Structuring

Knowledge) stands out [Matta et al., 2001]. MASK is an evolution of knowledge management of nearly 30 years, it is a well-structured method which allows the knowledge capitalization from experts in a specified subject, it is based on the interviews to experts, the modeling of the knowledge and the model validation from the experts [Aries et al., 2008].

3 METHODOLOGY

With the purpose of providing a clearer understanding and modelling the process of the Continuous Improvement, the following methodology is proposed (Figure 1). This is based on a knowledge management approach, more specifically MASK method and KROM (Knowledge Reuse Organizational Meta-Model) [Girodon et al., 2012]. This methodology, under the approach of Knowledge Management aims at capitalizing the knowledge from experts in the industry, to transform their tacit knowledge on explicit [Matta et al., 2001], for consequently sharing it and make it available to the use of the scientific community, and thus continue to contribute to the cycle of knowledge in the subject.

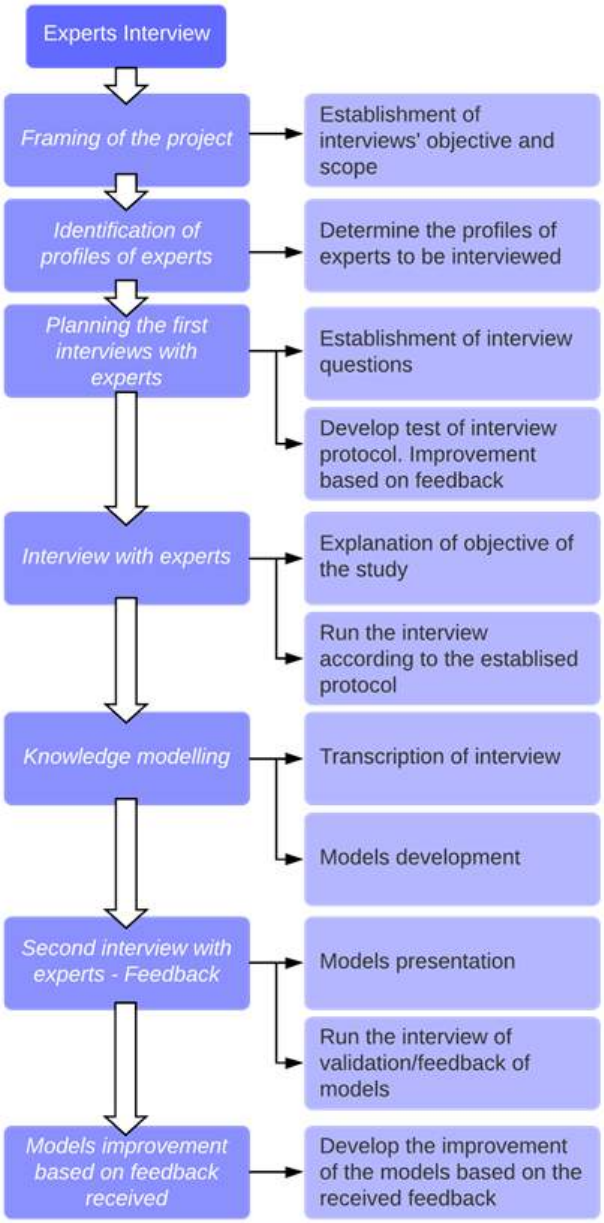

Figure 1. Methodology

For this study, the steps of MASK method as described in [Ermine, 2013; Ermine and La, 2003] were followed: starting with the framing of the knowledge capitalization project by establishing the objectives and scope. Followed by the identification of the profiles of the experts to be interviewed, for this, different organizations and locations were privileged, as experts' diversity is often seen as an important factor for taking into account different social practices [Nonaka and von Krogh, 2009]. Then, the planning of the interviews was done, for which, a series of questions and a protocol of interview were established and then tested to further improve them. After that, it is the actual interviews to the selected experts.

For the next step, based on the interviews, the knowledge modelling is done. For this study we opted to develop the knowledge modelling with KROM meta-model, as it is centered on organizational modelling based on knowledge [Girodon et al., 2012; Monticolo, 2015]. Through it, the organizational and process models are developed, for making it possible to clarify the Continuous Improvement process, by showing its goals, missions, subprocesses and the activities within them. After developing the models, an important step to follow is to develop a second interview with experts in order to have their validation on the gathered knowledge and feedback on the models for further improving them and confirm its accuracy.

4 RESULTS AND DISCUSSION

By following the MASK method, the first thing that was done was the framing of the project of knowledge capitalization, which is shown in (Table 1) and contains the objective and five w's and how. This is a very important step to do, as this gives us clarity regarding the scope of the knowledge field to clarify.

Table 1. Framing of Knowledge Capitalization project

	Framing of the project
Objective	To access and capitalize the knowledge of experts in Continuous Improvement, with the objective to understand and clarify its processes, activities, characteristics.
Five W's and How	
What	The domain of study is the process of Continuous Improvement in the industry.
Who	The group of experts to interview are industry professionals with vast experience on Continuous Improvement.
Where	The interviews are developed by videoconference due to the actual situation and for having access to a diverse group of experts.
When	Each interview is designed to last 1 hour maximum. The total length of the process, including modeling and second round of interviews (experts' feedback on built models) is about 3 to 4 months.
How	A first interview with a defined protocol is done with the experts for gathering information. Following, after analyzing and structuring the information, a second round of interviews with available experts is developed to validate the structured models and receive feedback for further improvement.
Why	Because there is a need to give clarity on how the actual organizational process of the

	Continuous Improvement in the industry is, looking towards a lower failure ratio on implementations and a future transformation of the process.

Based on the described framing, the profile of the experts to be interviewed was determined, also the protocol of interview with the proposed questions was defined, taking into account the models to be used. In order to validate and improve this protocol prior to interviewing the experts, a mock interview was developed with one of the authors, who has more than 20 years of experience in the subject to study. With the intention to get a diversity of context on the experts for proposing more generalized models, a total of 5 experts from 4 different companies (located in France, Switzerland, Mexico, United States) were interviewed. All experts have a vast experience in Continuous Improvement, with positions such as Managers, Directors and Expert specialists in Process and Operational Excellence, Lean, Production and Continuous Improvement.

After gathering and analyzing the information from each of the interviews, the authors proceeded to capitalize the experts' knowledge by means of the models proposed by KROM. Since the interview to the first expert, the models were developed and consequently improved with the knowledge from the subsequent experts. By this, it was possible to observe that besides the particularities of the context of each expert, their knowledge on the subject was consistent. It was observed that the experts shared the same vision on Continuous Improvement and through the process even some of their answers were very similar, meaning in this way that a good quality and pertinence of the knowledge that captured under this Knowledge Management approach.

To confirm the relevance of the models developed, a second round of interviews with two of the experts was conducted. In these, as suggested in the MASK method [Aries et al., 2008], the aim is to obtain feedback and validation of the models by the experts, which process is considered sufficient when there is nothing more to add to the models. One of these second interviews was at the beginning of the process, in order to validate the early stages of the models; and the other one at the end of the process, after capitalizing the knowledge from all of the experts and consolidating them into one set of unified and comprehensive models.

As results of the capitalization of the knowledge, Figure 2 and Figure 3 show respectively the organizational structure model and the process model for Continuous Improvement. The model in Figure 2 is structured for representing the three principal missions of Continuous Improvement: to give support to the improvement of the processes in the company, to guide the establishment of the performance indicators, and to maintain a high level of performance. At the same time, it can be seen that these missions contribute to the achievement of the following goals: to excel from the competition, to quickly adapt to customer's (either external or internal) expectations, and to allow the company to sustain itself over time. Representing in this way the identity of the Continuous Improvement, which is in fact very important to clarify, as we have seen that one of the failure reasons in implementations is actually the lack of alignment with the company strategy [Middel et al., 2007], as it is often not seen as the whole organizational process.

Moreover, for fulfilling the identified missions, they rely on five processes, namely: to give support to the problem resolution, support the performance strategy, to train and coach the

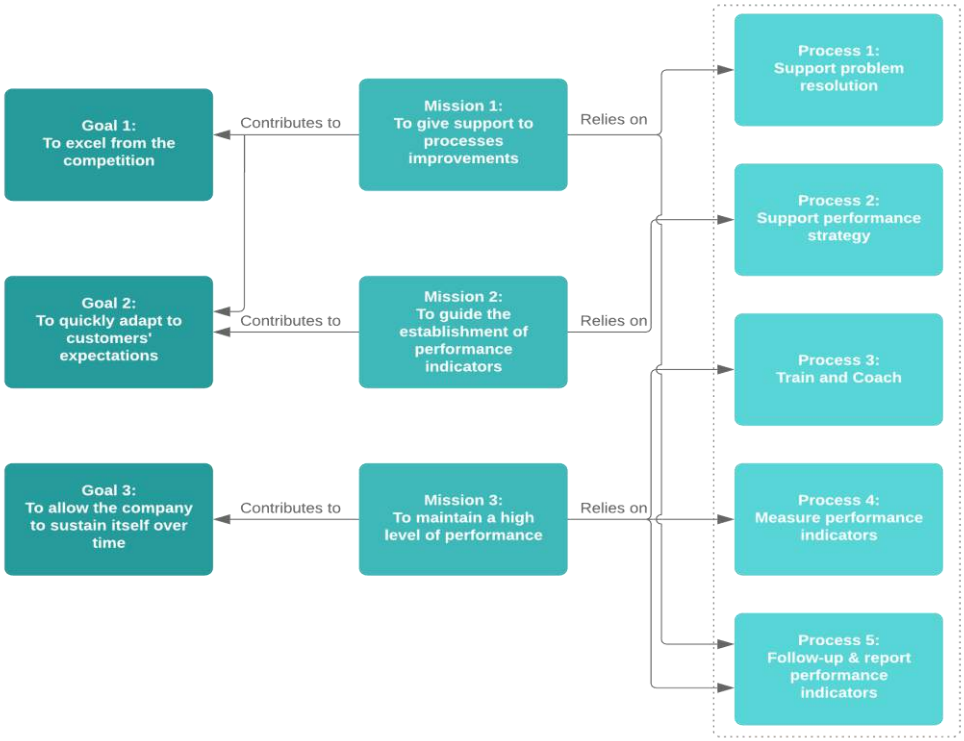

Figure 2. Continuous Improvement Organizational structure model

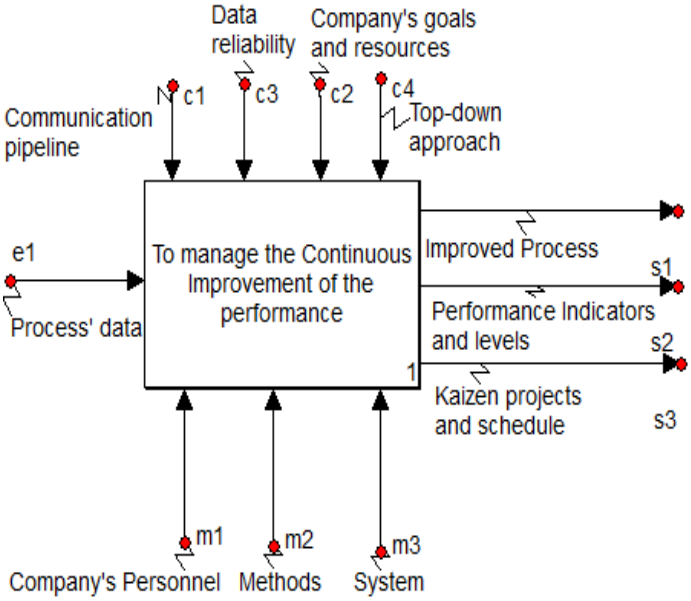

Figure 3. Continuous Improvement diagram A-0

personnel, measure the performance indicators, and follow up and report the established performance indicators. These processes can be consequently represented by the activities within them. This is done by the process model proposed by KROM, which is based on SADT/IDEF0. Thus, following in Figure 3 is represented the model of the whole process based on SADT, in which each of the five sub processes are contained. From the interviews it was possible to not only identify for each mission which are the processes that they rely on and how these missions are contributing to the goals. But also, it was possible to map the whole organizational process and to identify the activities within them, its entries (e), exits (s), controls (c) and mechanisms (m). From the five identified processes, as an example, in Figure 4 and Figure 5 we represent "support problem resolution" and "support performance strategy" respectively.

In the process model for "support problem resolution" (Figure 4) are represented all the activities that it is constituted by. In this, it was evidenced the critical importance of well-defined performance indicators, as well as the data reliability of its measures, in which the role of data manager is lately becoming more and more valuable. This process receives as controls and entries, among others, the performance indicators measure, their target levels, and their level of conformity.

These come from other of the defined processes (follow-up and report performance indicators, support performance strategy, measure performance indicators), and become crucial for the right development of this process in order to obtain the desired outputs (lessons learned, action plan performance indicators, improved processes). Which highlights once again the need to see the Continuous Improvement as a whose organizational process and not as isolated bricks.

Likewise, in Figure 5 is shown the process model for "support performance strategy". This represents a very crucial process, as in its activities we find: to support the establishment of the mission and vision of the organization, from which the performance indicators are identified and defined with its target levels (generally done under a top-down approach, but taking into account that the reporting usually follows a bottom-up one), then the dashboard in which they are going to be reported is

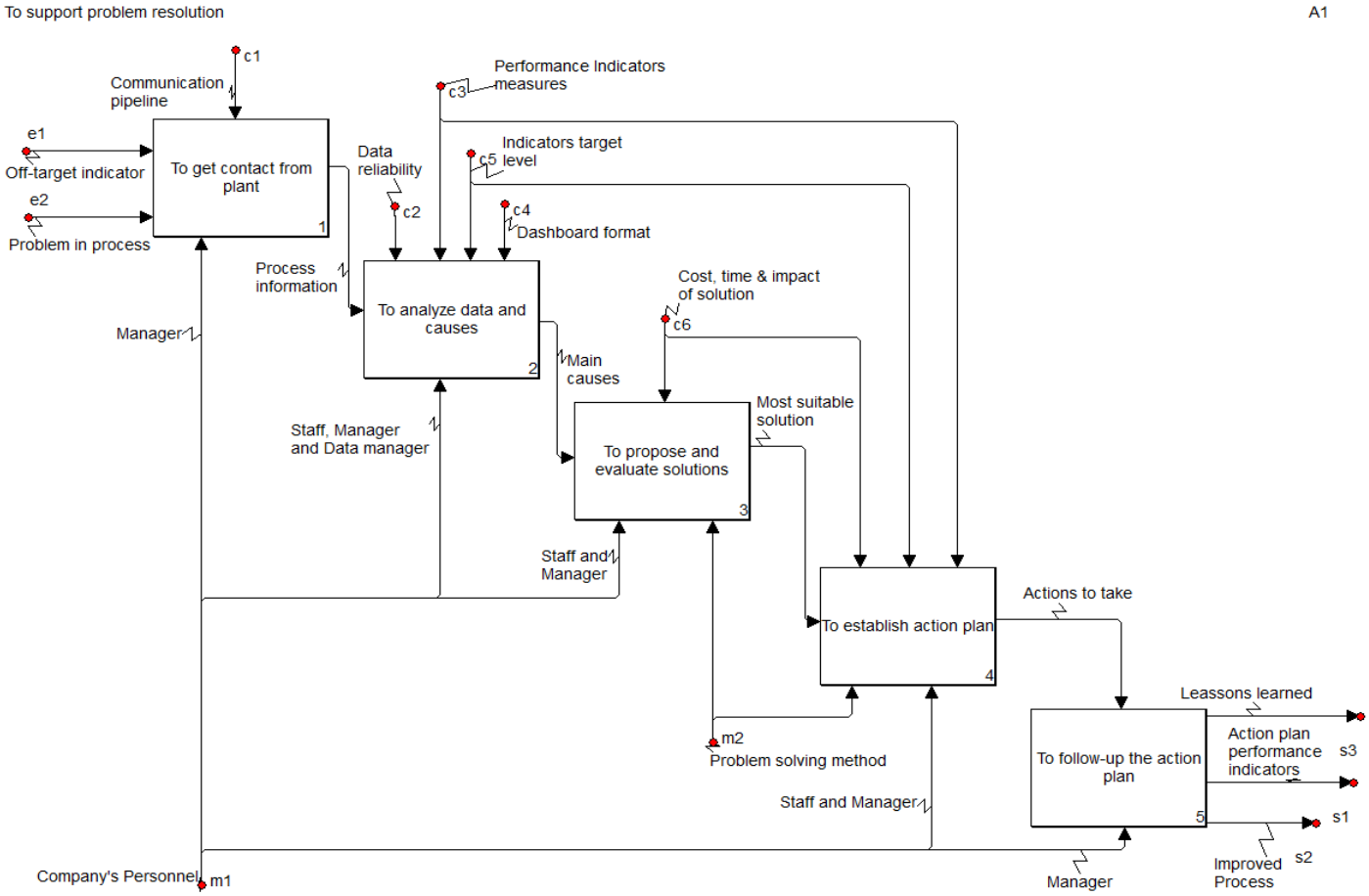

Figure 4. Process model: Support problem resolution

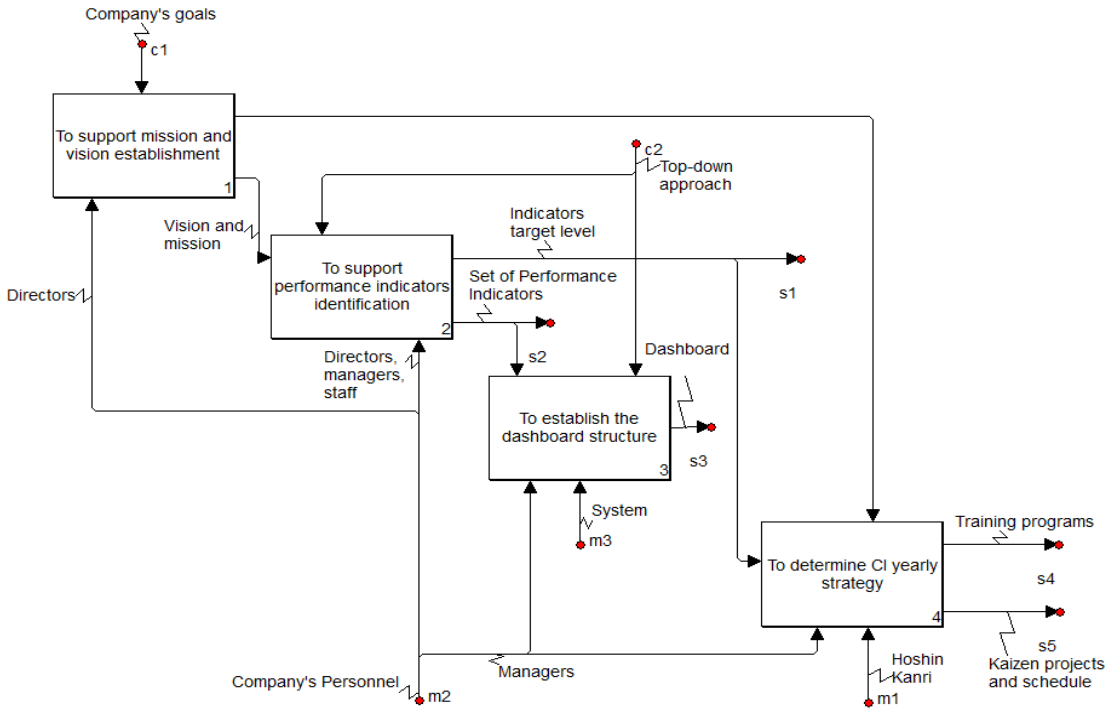

Figure 5. Process model: Support performance strategy

structured, and also it is determined the continuous improvement yearly strategy, with the training programs and kaizen projects and their schedule. Throughout the interviews, it was evidenced that even if the identification of the performance indicators plays a highly important role, it is mainly done by instinct. Its identification and dependability connection between the different levels of indicators (low, medium, high) represents without doubt an important room for further improvement and systematization.

Consequently, with the development of these models under a Knowledge Management approach, we seek to give more clarity on the organizational process of the Continuous Improvement, which is important and vital for the survival of the companies, but so far poorly studied as a complete process. A general and mostly agreed opinion among the experts is that Continuous Improvement is fundamental for companies seeking to be adaptable and competitive. It must be considered as an essential part of its strategy, no matter under which specific methodology it is implemented (Lean, Six Sigma, Lean Six Sigma, TPS…) or the way it is represented in the companies (a whole department, a group of experts, a shared philosophy with each process owner empowered). Thus, a clearer way to understand it, is shown in this paper, which is expected to be seen as a reference for the as-is process and later analyze the to-be one.

Moreover, the developed models can be confronted with another reference describing performance improvement requirements: ISO 9000 standards. In ISO 9001 standard (Fundamentals and vocabulary) [International Organization for Standardization, 2015], one of the seven principles of quality management is improvement. This principle reminds us that the success of an organization is based on a constant desire for improvement and proposes to bring the organization's processes under control. In ISO 9001 standard (Requirements), chapter 9 (Performance assessment) and chapter 10 (Improvement) are directly concerned with performance improvement, they broadly take up the elements presented in our model. Finally, in the ISO 9004 standard (Quality of an organization - Guidance to achieve sustained success) [International Organization for Standardization, 2018], the term improvement (in different forms) appears 146 times, thus, reflecting the great importance of this notion in this quality standard. By analyzing the standard, we believe that the models developed are in line with the standards, they are complementary. In our models we can find the processes and activities in detail, but the standard, in contrast with our models, opens the scope to the outside of the organization (in chapter 5.2 involves the interested parties for detecting opportunities for sustainable performance improvement, and chapter 10.4.3 talks about comparing the organization's performance with agreed benchmarks) and considers the practice of internal audits and self-assessments with the staff. The standards give a much more general vision, nevertheless with our models obtained from the capitalization of expert knowledge, we propose a more detailed vision that can become a great insight for practitioners.

5 CONCLUSIONS

This study developed the organizational and process models of the Continuous Improvement, intending to give a better understanding, highly motivated by its fundamental role for organizations. This was developed under a Knowledge Management approach, following the MASK method, and capitalizing the knowledge of the experts through the models proposed by KROM. This study is providing in the results, a model depicting the three goals, three missions and five processes of the organizational process of Continuous improvement, as well as the activities within two of these processes. With this, we intend to give more clarity and to help towards the creation and sharing of knowledge in order to help

to reduce the failure rate in the implementation of Continuous Improvement initiatives.

Furthermore, these models represent how the Continuous Improvement is being managed and developed in the industry nowadays, however the authors believe it is important to be conscious that it should be evolving along with the changes in the environment, like the fourth industrial revolution, which should take us to further adapt and improve it. In this regard some key elements were identified in the interviews, like the importance of continuously tracking the performance and the analysis and reliability of the data, for improving the decisions management and base it on data instead of just intuition.

The results from this study could lead to various perspectives and applications, with the developed models, a more understandable view of the Continuous Improvement is given, which could become the basis for guiding practitioners through its implementation and for developing a diagnosis of the Continuous Improvement process in the companies. It could allow based on this process, to propose a decision-making system for helping engineers and managers to better analyze and improve the performance. It could as well be the starting point towards an analysis for the improvement of the process, as for this, having a clear understanding of the process is a must. And finally, for developing the digitalization of the workflow of the process in order to have a better visibility and control.

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