BPMN and Lean Contributions for the ISO9001 Implementation: A Case Study within the Plastics Industry

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Abstract

The increasing level of competitiveness and pressure to which companies are subjected today has led to a greater demand for quality management certifications that validate their processes. For this, the need to continuously analyze, improve, and standardize all the business processes involved becomes urgent. Business process management (BPM), which includes modeling, appears as a response to that need, often leading to processes dematerialization. However, standardization alone is not enough to increase a company's competitiveness. It is necessary to combine continuous improvement through the use of Lean tools, once they are suitable for identification and, consequently, for the elimination of waste and non-added value activities (NVA). This work appears with this need, having as objective the proposal of a methodology that combines the concepts of Lean and BPM, using for the process's representation the notation BPMN 2.0 (Business Process Model and Notation). The methodology was tested in a case study that involved a newly-created company belonging to the plastics industry and the results contributed to the preparation, initialization, and conclusion of the certification process with the quality standard, ISO9001: 2015.

Keywords
Business Process Management, BPMN, Processes Standardization, SDCA and Lean.

1. Introduction

In a market that is increasingly based on strong industrial competition and driven by the pressure of consumer's demands, companies need to obtain different types of certification, especially Quality Management Systems (QMS) related. Certification in QMS is governed by the documentation of the processes, procedures, and responsibilities involved in complying with pre-established quality measures, through standardization techniques (Mohanraj & Kumar, 2019). The most worldwide used certification is ISO 9000 standard. It is a family of quality management standards that establish a set of international metrics in the area of Quality Management and Quality Assurance and that support company to raise their management performance to reach the level of Total Quality Management (TQM) of the organization ("ISO 9000 family — Quality management," 2020)

However, process standardization to obtain a certification is not sufficient to raise the competitiveness level of a company. The focus on the processes continuous improvement through the use of Lean tools in a perspective of identifying waste and non-added value activities (NVA), can be a solution to improve this competitiveness. William Thomson (British physicist also known as Lord Kelvin), defended through his expression "If you can't measure it, you can't improve it" (Jaramillo & Richardson, 2016) that you can only improve what you can measure. In this sense, the

creation of models and standardization mechanisms may be a lever for the improvement phase, to obtain more effective and efficient processes.
However, after reaching this process's knowledge base through standardization there is a need for continuous improvement. Therefore, it exists for this purpose a set of Lean tools to identify waste and NVA activities. With the need for organizations to have their processes mapped, standardized, and with constant control and improvement mechanisms, there is an added difficulty that can be mitigated with the use of Information Technologies Systems (IT / SI). Thus, IT / SI ensures the existence of a knowledge base, where all the processes related information is registered, as well as the actors that will have access to that specific information (Castela, Dias, Zacarias, & Tribolet, 2013).
Accordingly, this paper presents a methodology which resulted from the combination of two previously known concepts - the BPMN (Business Process Model and Notation) and the SDCA (Standard-Do-Check-Act) - a methodology that came to support the business processes standardization of a newly created company belonging to the plastic industry has contributed to the initialization and achievement of the QMS certification process, through the ISO9001: 2015 standard.
In the first phase, processes were identified and modeled using the BPMN2.0 notation. Then the mapped models were analyzed, to obtain more efficient ones using, for this purpose, a set of Lean tools. In the next phase, the processes were standardized using the SDCA cycle of continuous improvement to achieve a long-term stabilization in process-oriented management.
This article is structured in four main parts. The state of the art can be found in section 2, followed by the resulting methodology of the study, in section 3. The findings from the application of the methodology in a real practical case appear in section 4. The last one is dedicated to conclusions and future work.

2. State of Art

2.1 Related Works

Countless authors focus on the concept of Lean and BPMN, but few works on them together. In 2013, Castela et al. (2013). proposed a “collaborative method to update the business process model”, MACoP, to reduce the difficulty felt in standardizing and maintaining processes. This method was applied and studied in five Portuguese organizations resulting in a mechanism that allowed to involve the actors in the validation processes of the models, aligning them with reality in an interactive way (Castela et al., 2013). Later, in 2016, Girardi Tegner, Nascimento de Lima, Veit, & Corcini Neto (2016) proposed a method for the implementation of Lean Office and that incorporates concepts of Process Management. The authors evaluated this new method in a case study where they state that the proposal "demonstrated effectiveness" and the possibility of application. Although it can be generalized in other contexts it does not contemplate a way to guarantee the processes standardization before improvements can be made, with only a contribution from the Lean tools throughout the process management described by the authors.
More recently, a study has also been carried out to identify the economic benefits related to standardization through ISO 9000 certification. The authors, (Mohanraj & Kumar, 2019) reinforce the contributions of standards to improve the productivity and performance of organizations. Also, the work of Arromba, Teixeira, & Xambre (2019), carried out an exploratory study in an industrial context where they resorted to the concepts of Lean and BPMN. This study had as main objectives: (1) to emphasize the importance of modeling processes during data collection, analysis, and visualization of standard procedures; (2) prove the importance of reducing inefficiencies in information flows. For this purpose, they used methods and principles of Lean, Information Systems, and Industry 4.0. An approach where BPM has allowed a greater understanding of processes to achieve comprehensive solutions concerning processes in need of improvement. However, the problem presented here regarding the standardization of business processes is not discussed.

2.2 About BPM and Lean

A common aspect of organizations is the existence of processes that define how work is carried out by the resources associated. Each organization - be it a “government agency, a non-profit organization, or a company - has to manage a large number of processes” and can use, for this purpose, the concepts related to the management of business processes (acronym known in English as BPM (Business Process Management)) (Dumas, La Rosa, Mendling, & Reijers, 2013). In the context of BPM, there is the concept of business process modeling, which according to the definition of Závadský & Závadská (2014) means “An orientation by processes, of a management system, which can be achieved through the application of a process approach”, including all organizational activities holding information on 'how', 'who' and 'when' activities are carried out. But for a company to be able to claim that it effectively follows a process-based approach, it will have to have a map of all processes, which translates into the “set of related and

structured activities carried out by one or more are organizations to achieve a certain objective" (Stajniak & Koliński, 2016). To harmonize this concept of BPM with the concept of standardization, there was a need to create a universal modeling language, so that it was understood by all stakeholders.
The Business Process Model and Notation (BPMN) brought standardization of the icons used to design the activities and flows of the respective processes, as well as to represent the inherent decision-making. More recently, the latest version, BPMN2.0, developed by the Object Management Group (OMG), emerged as a way to minimize the differences and the distance between the actual behaviors of the processes and those desired, thus allowing a more direct execution of the business process (Geiger, Harrer, Lenhard, & Wirtz, 2018). This latest version has thus become a reference for being a simple and versatile alternative for the modeling of companies' business processes, serving different purposes (Corradini et al., 2018). Another characteristic of BPMN2.0, which became evident early on, is the possibility of modeling collaborations between different organizations, allowing an exchange of information in the sense of cooperation, to achieve shared goals (Kherbash & Mocan, 2015). Additionally, it was found that the BPM cycle is a process management cycle, where Lean tools can occupy a prominent place through the adoption of a continuous improvement thinking, even during the analysis and redesign phases of the AS-IS, resulting from the first phase of the processes discovery.
The focus on processes that create added value for companies, increasing their level of competitiveness through the elimination of activities that do not generate any value to the final result, is at the base of Lean and BPM methodologies. After preparing a value analysis of the activities that make up the processes, Lean tools have great potential to assist in the reduction/elimination of activities that do not add any value to them. Among all the existing tools, and due to the countless advantages they bring to the business world, the following stand out: KANBAN (Lolli, Gamberini, Giberti, Rimini, & Bondi, 2016); "5 Why's" (Perry & Mehltretter, 2018); concepts of work ergonomics with increased efficiency in productivity (Alsaffar & Ketan, 2019); ANDON (Minh, Nguyen, & Cuong, 2019); visual management through operational staff (Bateman, Philp, & Warrender, 2016); dimensioning of supply supermarkets (Emde, 2017); concepts on layout optimization, using the spaghetti diagram (Senderská, Mareš, & Václav, 2017); 5 S's (Boca, 2015); and yet, the Obeya Room (Javadi, Shahbazi, & Jackson, 2013). For a successful implementation of these tools, their application must be done in a planned manner, with well-defined objectives and action plan a priori.
The PDCA cycle (Plan-Do-Check-Act) or also known as the Deming cycle, a worldwide known tool for managing process improvement, ensures that the company's culture focuses not only on improvements but mainly on its correct and continuous execution (Jagusiak-Kocik, 2017). It is also from this tool, the PDCA cycle, that the SDCA cycle of continuous improvement appears. The main purpose of this cycle is to standardize processes subject to improvement, as well as to ensure "the stability of existing standards", even before any changes are made (Stojkic, Majstorovic, Visekruna, & Zelenika, 2014). As can be seen from the graph in figure 1, where the intention is to show the interaction between the two cycles, the initial stability of a process is ensured by the implementation of consecutive SDCA cycles. In this way, it is possible to resolve anomalies that may arise during an established process and bring it back in harmony before moving on to a new cycle of continuous improvement, through a Kaizen event with the PDCA cycle. Only with several interactions between the two cycles over time will it be possible to achieve a higher performance of the processes.

Figure 1. Framework representative of the interaction between the SDCA and the PDCA cycle

Therefore, regardless of the techniques adopted to improve the models created, any changes made and validated by the organization must always be standardized. This standardization should be frequently revised, incorporating changes whenever necessary (Stajniak & Koliński, 2016). Only then will it be possible to have the current processes always accessible to the entire organization, improving quality management, and increasing the possibility of obtaining certification of this type. As noted at the beginning of this section BPM offers much of the knowledge necessary for an organization to map, analyze and manage its business processes as efficiently as possible, especially when faced with the concepts of modeling and standardization. But given the high interest by companies in orienting their culture towards continuous improvement, a new question arises: "How to manage processes in Kaizen environments, in a mapping, standardization and continuous improvement cycle?"

3. Methodology

To answer the question raised above, a methodology is proposed that combines emerging approaches from BPM and Lean philosophy, more specifically through the SDCA. This merger aims to expose the synergies that exist between the management and mapping of processes through BPMN and standardization in a more stable phase of the cycle, considering the philosophy of continuous improvement (Kaizen). This methodology, which has been called BPM@SDCA, is represented in the framework of figure 2.

As seen in the framework, the first step of the methodology is to define and prioritize the areas of the company to be the target of the action, scheduling for each of them the various phases of the methodology. Steps 2 and 3 represent the junction of the two cycles previously identified, which will be covered for each process detected in the first stage of the BPM cycle. This cycle consists of 6 continuous phases, which are: process identification; discovery; process analysis; redesign; processes implementation; control, and monitoring. In this work, only 4 phases will be approached, that is, the identification of the process, followed by the discovery phase, where the AS-IS model is obtained, then the analysis and redesign phases of the process to obtain the TO-BE model, which serves as a bridge for the initialization of an SDCA cycle. This first discovery phase consists of creating a body of knowledge of the domain about the processes to describe models that reflect the real business process that is intended to be modeled. At this stage, after defining the participants involved in the creation of the models, it is necessary to infer about the various techniques for discovering processes to be used. Among them, the most used are evidence-based discovery, interview-based discovery, and discovery-based on workshops (Dumas et al., 2013). The triangulation of the information obtained by the use of various techniques usually allows improving the results leading to obtaining the AS-IS models. In turn, the TO-BE model achieved after an analysis and redesign phase will facilitate the standardization phase, now within the SDCA cycle, providing the standards to be documented and made available by the company. The SDCA cycle should be 'run' as often as necessary until there are not enough actions from the 'Check' phase or also known as the 'Implementation' phase to justify starting a new cycle.

It remains then to replicate steps 2 and 3 to all processes identified in the first phase of BPM, described in step 4 of the framework. To model the processes, BPMN2.0 is used for all the advantages presented in the previous sections, namely the flexibility and the fact that it is the most recent language centered on processes and validity by OMG.

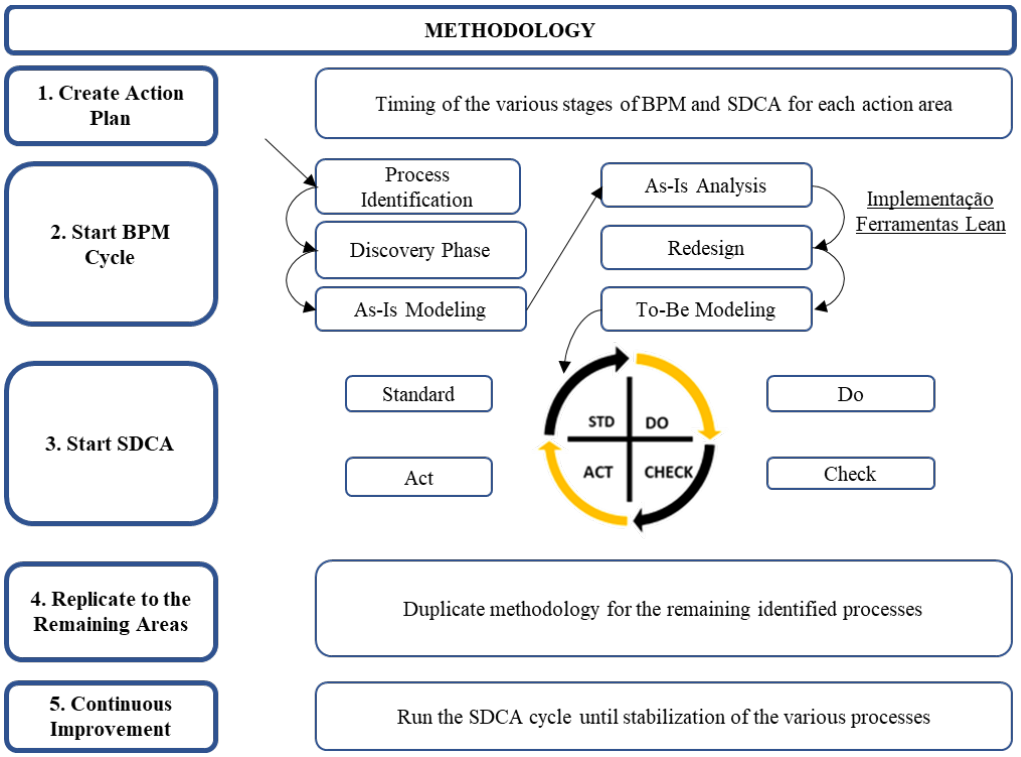

Figure 2. BPM@SDCA Methodology

In this context of interaction, the synergies between the two approaches will be exposed and greater efficiency and effectiveness are expected in obtaining standardized processes in the organizational environment, as well as their long-term stabilization.

4. Case Study

The present case study, where the proposed methodology was applied and tested, took place in a newly created Portuguese company, belonging to the plastics industry and inserted in a leading group in the market and with a growing international presence in the area of accessories for bikes and off-road motorbikes. This company, which was only two months old from the time it tested the proposed methodology, produces, standardizes, and sells sports water bottles at a price and a competitive lead-time in the European market. Its requirements were the need to map and define the standards of the existing processes, both those adapted from the parent company of the group in which it was inserted, as well as those created from scratch for this new business context, which differed from the other companies in the organization. It also intended its analysis to make them more efficient, including them in a continuous improvement thinking. Thus, it started with the application of the methodology described in the previous section, through the identification of all the processes that initially existed in the company and proceeded to the discovery phase for each one of them. Still at this stage, a set of techniques for discovering processes was used, namely: structured interviews; workshops; evidence-based methods, mainly through direct observation. Data triangulation method was used to validate the convergence of the information obtained through the three techniques for discovering the above-mentioned processes. Then the respective AS-IS models were built, using the BPMN2.0 notation for this purpose. Figure 3 intends to illustrate an example of one of the AS-IS models obtained related to a process, in this case, the silkscreen production process. For contextualization, this process is not mandatory and occurs whenever the customer requests a personalized impression on the water bottle.

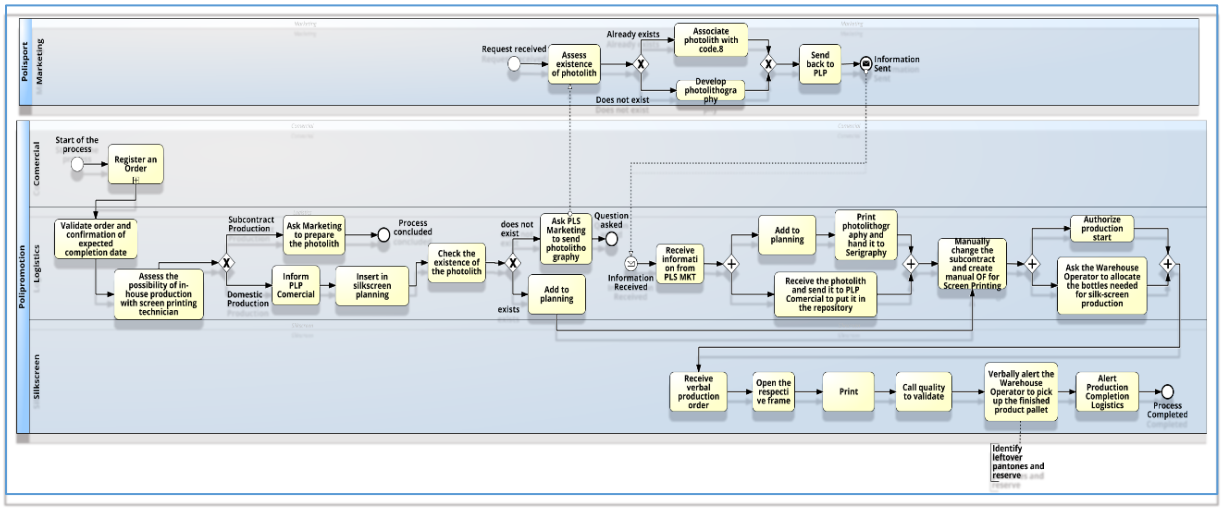

Figure 3. AS-IS model in BPMN2.0 of the silkscreen production process.

This model then served as a starting point to carry out a value analysis of the activities that constitute it, by the "process analyst" (Halaška & Šperka, 2019). This analysis took into account the identification and documentation of all problems that were encountered, the differentiation of VA from those that did not add any value to the process (NVA) and the decision on which are the focus of action for the implementation of improvements (Minh et al., 2019).
For the case under study and given the immaturity of the processes, it would be expected to detect a high number of activities that only represented waste for the company, both in terms of time consumption, space and Work in Progress (WIP), reflecting an increase in the internal costs. This conjecture was confirmed with a sum of NVA activities of approximately 57% of the total silkscreen process activities. For the problems found, targets of action focus, improvements were proposed, and whenever possible using Lean tools. The creation of KANBAN to support production planning, with different colors for each productive department, including printing where this process belongs, allowing the transport of manufacturing orders to be easily seen and more efficient. Brainstorming sessions were carried out using the "5 Why's" tool to find the root causes of the problems that were being pointed out. Jobs were considering the work ergonomics and the factory layouts were optimized considering the concepts of a spaghetti diagram. More efficient supply supermarkets were also created and adapted to the dimensions of the production lots. As a result, approximately 11% of the total initially occupied area was reduced. In an initial phase, simple ANDON manuals were built to facilitate internal communication between employees, and 5S's sessions were held in the various departments of the factory. To culminate, an Obeya Room was created where weekly meetings were held across all departments of the company and which contained several writing boards with quality tools as Ishikawa and 5 why's diagram, to be used in the company's day-to-day activities. There, some daily KPIs of common interest to the management team and factory operators were made available for analysis. The proposed improvements were being implemented and the initial models were redesigned to obtain more efficient and capable ones, called TO-BE models. Figure 4 illustrates the TO-BE model obtained after analysis and redesign of the respective AS-IS model previously presented in figure 3.

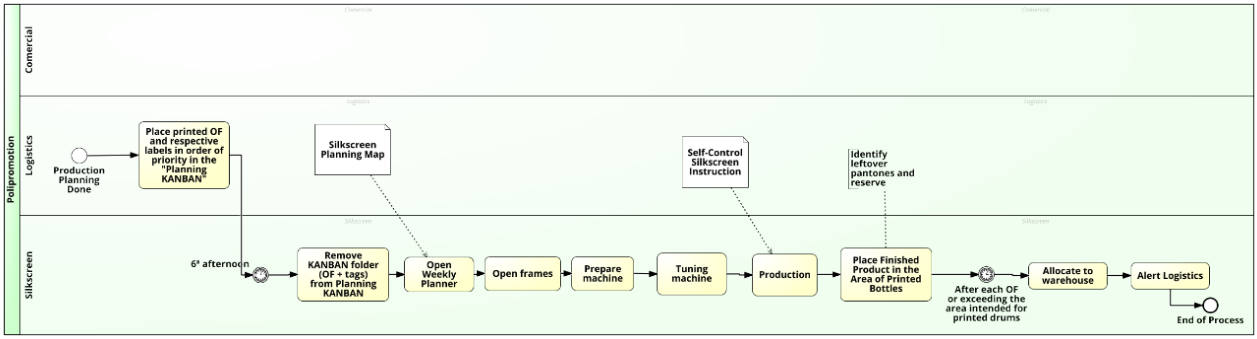

Figure 4. TO-BE model in BPMN2.0 of the silkscreen production process.

As can be seen in terms of the macro aspect of the model, it is easy to see a great reduction in NVA activities and a simplification of the process flows, corresponding to a better understanding from participants about the set of activities to perform. Due to the methodology, more than betting on improvements, it is essential to ensure that these are put into practice and that is why the TO-BE models serve as a bridge for the start of a new SDCA cycle. The first phase of 'Standard' consisted of including all TO-BE models in the process templates and making them available on the online platforms that existed in the group and which were found to be sufficient to meet the daily needs of the organization, ensuring that employees had access to their consultation (Knowledge Base). It is also important to highlight the training that was given to all company employees, from the factory operator to the director, which consisted of presenting the TO-BE models, the main changes that occurred since the AS-IS processes, the availability of documents and clarifying their location and ways of access. Given the training, all activities were implemented on the shop floor and monitoring was carried out on the ground to verify whether the processes were being put into practice.
Following the SDCA cycle, more detailed in figure 5, the monitorization of the implemented processes was inserted on the "Check" phase, consisting on the compliance verification of the standards to be followed.

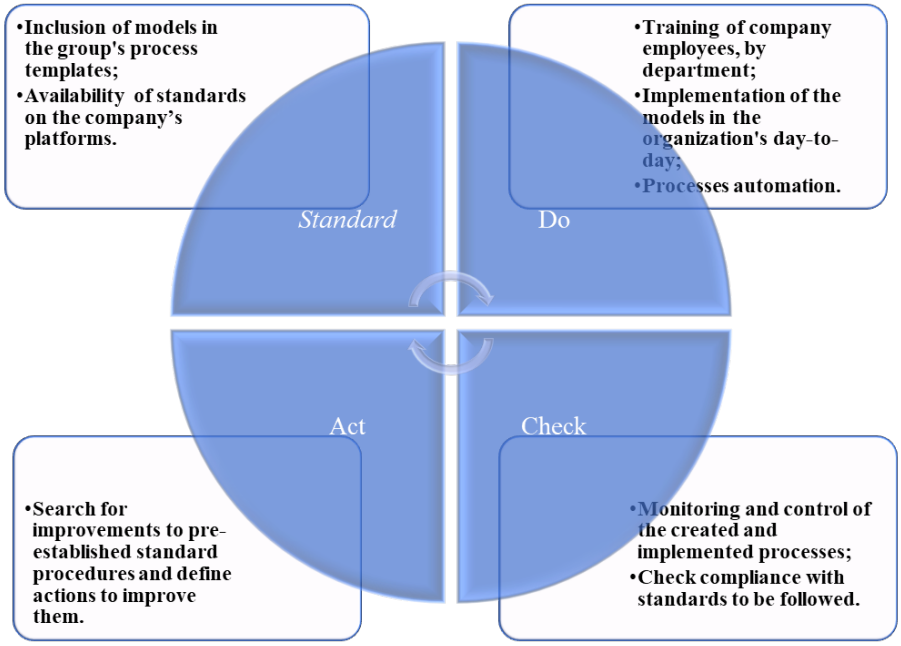

Figure 5. Detailed view of the SDCA cycle

Monitorization results can be observed in figure 6, where main processes are represented as well as the number of activities that comprise them. As a result of this monitoring, the execution of almost all the activities constituting the new implemented processes was validated, and only in the silkscreen production process and in the assembly process, a small part of the activities was not being fulfilled by the employees, respectively (11.1% and 2.9%).

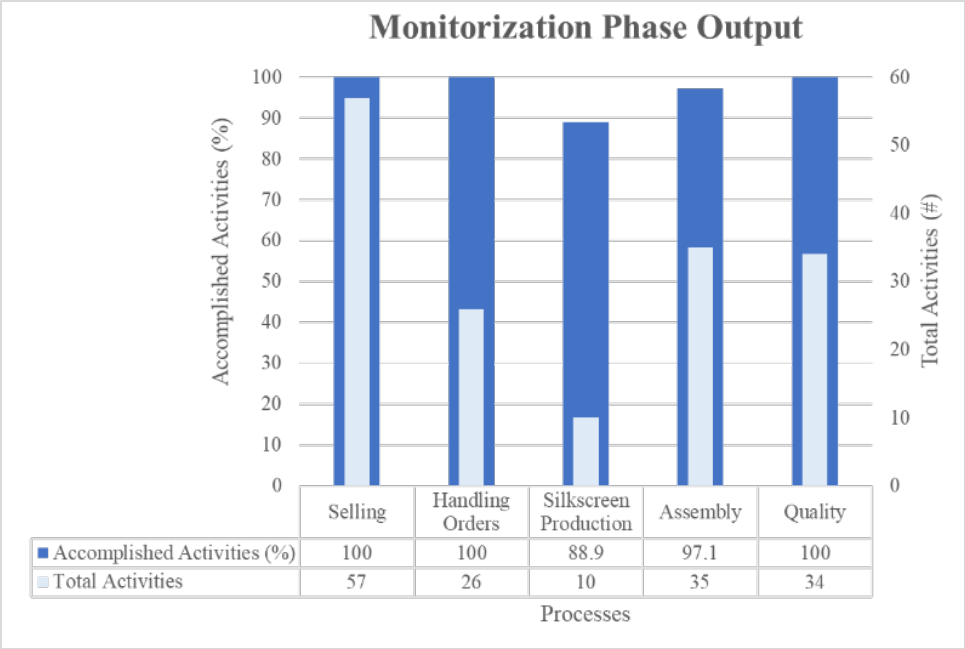

Figure 6. Processes monitorization outputs included in the "Check" phase

After this standards verification of compliance, went to the last phase of the cycle, the 'Act' phase, by searching for improvements in the pre-established pattern procedures and defining actions or corrective measures for its improvement in order to achieve the maximum level of activities performed according to the designed models. Finally, the SDCA cycle was run until there were no more deviations from the processes during the 'Check' phase.
Reaching this level and returning to the graph in Figure 2, the company was able to initialize a new Kaizen, through the improvement of stabilized processes.
Keeping this methodological pace, it started its quality certification process, including the company's processes already stabilized within the structure and quality standards existing in the group to which it belongs.
A year and a half after the beginning of this project, the company managed to achieve the desired certification, ISO9001: 2015.

5. Conclusions and Future Work

The proposed methodology, which combines the BPM and SDCA approaches, allowed a newly created company to start and achieve the certification process in the Quality Systems standard, ISO9001: 2015, after only a year and a half the begging of this project. The processes standardization supported by the SDCA cycle and the respective availability through existing platforms were also based on this success.
The BPMN2.0 language stands out for its simplicity and for the ease with which company employees interpret the models even if they have never had previous contact with it, as occurred in the presented case study. The fact that this company was only two months old from the moment the study and the methodology application was started also demonstrates the versatility of the methodology for its replication in other organizational contexts.
Also, the use of Lean tools to improve processes allowed the elimination of the NVA activities that were identified, as well as the creation of continuous flows through the simplification of the models.
BPMN modeling appears as a bridge between the application of process-oriented Lean tools and the models obtained and made available by employees, thus allowing their correct maintenance.

As future work, the aim is to improve the methodology, integrating the concepts that emerge in the new digital age to respond to the customers' needs in the area of processes, while including the requirements arising from the business world in response to the 4th industrial revolution. This objective will allow greater synergy between concepts, all of which are committed to a common purpose: (i) to facilitate access to business process models; (ii) allowing the models to be updated in real-time to make companies faster and more agile, through the implementation of digital technologies that transform business operations; and, further (iii) enhance the digital representation of companies in response to the needs of the 'Digital Twin'.

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Biographies

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