Improving business process management for product-centric service organization: the case of aerospace maintenance project

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Abstract: Aerospace maintenance, repair, and overhaul (MRO) organization is a complex process that has elements of the traditional manufacturing industry and service industry. One of the challenges is to recognize the balance of strategic goals between both sides. Because aerospace maintenance has strict and high-quality requirements defined by airworthiness regulations, this paper focuses on improving a service-oriented process adaptation to quality regulations and customer demands with business process management approaches. The paper studies the role of business process management to improve process flexibility and performance. A case study of a large corporation is conducted to identify the business process management (BPM) context of the organization and process activities through interviews and participant-observation techniques. The methodology and BPM approach are valuable ways to improve process flexibility to achieve performance goals.

Keywords: Business process management, Aeronautical industry, MRO, Maintenance, Case study.

1 Introduction

Airlines spend billions of dollars every year to comply with the maintenance requirements defined by airworthiness authorities to guarantee the safety of passengers and aircrew (Vieira & Lavorato, 2016). In an attempt to reduce costs, airlines are partially or fully outsourcing their maintenance activities to aerospace maintenance, repair, and overhaul |(MRO) companies. Outsourced heavy maintenance checks for some aircraft can be a cost-effective maintenance strategy for airline companies (Bazargan & McGrath, 2003). Thus, the overall intent of the MRO industry is to minimize overall maintenance costs, reduce aircraft turn-around time and drive services with precise quality and safety standards (Ayeni, Ball, & Baines, 2016; Thomas, Mason-Jones, Davies, & John, 2015).

MRO activity is a complex process that involves a combination of technical, administrative, managerial and supervision activities. Its goal is to deliver aircraft in a state in which they can perform their required design functions (Ayeni et al., 2016; Ucler & Gok, 2015). The definition of the MRO industry described by Al-Kaabi, Poer, & Naim (2007) emphasizes features of the environments of traditional manufacturing companies and the environments of traditional service companies. According to Ayeni et al. (2016), it is possible to define the primary function of the industry as manufacturing activities, representing restoration activities for the product (aircraft) that allow it to continue to operate with the defined quality and safety criteria. In contrast, the industry as a service business can be defined as a service provided to airline companies in the form of aircraft maintenance.

The integration of service and production management strategies remains a challenge for aircraft maintenance companies. This challenge is related to the particularity of the definition of these organizations, including conflicting goals for operation costs and desired service levels (Samaranayake & Kiridena, 2012). The constant changes required for the process management of aviation maintenance represent an additional complexity for this type of company. These changes may come from new aircraft types, new customer contracts, and/or new quality requirements from a customer or governmental regulations for aviation maintenance.

Some companies have developed satisfactory maintenance procedures to overcome these challenges. However, intense globalized competition has resulted in organizational change and the re-design of management strategies in many aircraft maintenance companies (Jalil, Bakar, Khir, & Fauzi, 2017; Palma-Mendoza & Neailey, 2015). This new market environment has led companies to restructure and implement new process management strategies to optimize their maintenance production and increase their performance results (Ayeni et al., 2016; Bierer, Götze, Köhler, & Lindner, 2016; Somarin, Asian, Jolai, & Chen, 2018; Thomas et al., 2015). As a result, business processes are under constant pressure to reduce maintenance turn-around time, reduce inventory costs, increase product data, and improve quality based on the market competitiveness.

To meet these new goals, business models should work across organizational silos that may include planning, engineering, supply chain, properties, procurement, information technology, and human resources functions (Ayeni et al., 2016; Shay, 2018; Ucler & Gok, 2015).

In this context, the uniqueness of the MRO industry demands that the implementation of management strategies is not limited to production activities but also includes service-oriented activities. In particular, the application of process management methods to integrate the complexity of heavy maintenance activities into service-oriented functions remains a challenge. Therefore, the development of a comprehensive business process management approach that is aligned with the organizational architecture and project portfolio is essential to facilitate business performance and increase quality management for heavy maintenance projects.

Various management practices have been developed to improve MRO business performance. Some studies investigate the implementation of lean six sigma principles in MRO business process (Ayeni et al., 2016; de Jong & van Blokland, 2016; Ford & Gadkari, 2005; Thomas, Francis, Fisher, & Byard, 2016; Thomas et al., 2015) to improve productivity efficiency and cost-effective strategies. Quality management strategies have produced satisfactory results by reducing costs and time operations (Ayeni et al., 2016; Khaled, 2013; Thomas et al., 2016).

Other studies show that mathematical modeling approaches can minimize cost by analyzing value-adding activities (Bazargan & McGrath, 2003), developing simulations with process flow designs (Vargas & Calvo, 2018) or providing business benefits for MRO and OEM relationships (Goncalves & Kokkolaras, 2019). A new line of research has focused on supply chain interaction to improve parts inventory, resources and operations with different models and frameworks (de Souza, Tan, Othman, & Garg, 2011; Goncalves & Kokkolaras, 2019; Kumar, Sharma, & Agarwal, 2015; Somarin et al., 2018). Palma-Mendoza and Neailey (2015) apply business mapping and different tools in a methodology that re-designs business processes to support supply chain integration. The authors use this approach to analyze the flows and clarify the relationships of supply chain processes.

Following the increase in the use of new technology, business process management was proposed to integrate the MRO process and system information (Bierer et al., 2016; Jalil et al., 2017; Ucler & Gok, 2015; Wu, Li, Wang, & Liu, 2016) to provide a more collaborative system, data analysis, and digitalized management. According to Esposito, Lazoi, Margarito, and Quarta (2019), business process integration with digitalization can contribute to managing processes with work-in-progress knowledge and can be an approach for process improvements and the control of activities.

Because aerospace airworthiness regulations demand excellent maintenance operations with strict quality control procedures and an efficient quality assurance program (Ucler & Gok, 2015), ensuring the quality of services and processes for each aerospace heavy maintenance project is a key part of the MRO industry. Although management strategies and models have been investigated to improve MRO business processes, the interaction between processes and data levels is still lacking, (Samaranayake & Kiridena, 2012) including management strategies for service-oriented activities (Ayeni et al., 2016). Research has identified the use of incomplete and inadequate practices related to spare parts and inventory management, information management, planning and leadership across functional business processes within an organization (Goncalves & Kokkolaras, 2018; Samaranayake & Kiridena, 2012; Thomas et al., 2015). Accordingly, process management approaches based on customer requirements for maintenance operations and service-oriented tasks in a heavy maintenance project are still not well exploited.

The main objective of this paper is to improve MRO process flexibility and the integration of service-oriented processes with the use of business process modeling approaches. Additionally, the paper describes the MRO business process goal and context to provide insights into the business management strategies of the industry case. This study involved an MRO facility that conducts heavy maintenance for different airline customers. The case study was developed to integrate a process management perspective on the relationship between MRO activities and quality assurance functions that supports a core process.

2 Theoretical Background

Business process management (BPM) has been used in many studies to ensure continuous improvement in an organization's performance. The first challenge of process management is finding a balance between project objectives, including customer satisfaction, financial goals, and quality requirements. Research has demonstrated that BPM can be explored as a holistic management approach that is outside of individual tasks and a silo mentality and that supports a cross-functional orientation to customer value (Schmiedel, vom Brocke, & Recker, 2013). According to Burlton (Vom Brocke & Rosemann, 2010), process management can be maintained at all levels of an organization and aligned with the corporate strategy. Thus, business process approaches can be a valuable tool for managing processes and building enterprise value chains (Fleacă & Fleacă, 2016).

Aerospace maintenance is regulated by airworthiness regulations, which represent a strict process and high-quality standards. Specific business processes must be included within the organization to ensure regulations and support customer demands. Ucler and Gok (2015) proposed the application of business process management, which represents a valuable approach to minimizing paperwork and increasing functional management. Somarin et al. (2018) highlight the necessity of the operational flexibility of MRO service providers to ensure the service parts inventory. Aerospace maintenance is implementing new approaches to achieve a more cost-effective strategy for customer satisfaction. Some key factors of MRO activities are defining business strategies based on customer demand and the use of data analysis with system information that is easily obtained (Thomas et al., 2015)

In this context, BPM aims to improve and manage organizational processes to provide maximum value to the customer (Trkman, Mertens, Viaene, & Gemmel, 2015). To better manage processes, organizations must understand their environment and requirements to choose an adequate workflow approach that will support business processes within the organization (Benner & Tushman, 2003; Meidan, García-García, Escalona, & Ramos, 2017). Digital management is insufficient without the involvement of people (de Souza et al., 2011) and knowledge management that is directed toward process management (Dalmaris, Tsui, Hall, & Smith, 2007; Paschek, Ivascu, & Draghici, 2018). Furthermore, BPM models should consider the maturity level (Bucher & Winter, 2014). Other success factors of BPM are detailed in the literature (Buh, Kovačič, & Štemberger, 2015; Rosemann, 2014; Rosemann, Recker, & Flender, 2008; Schafermeyer, Grgecic, & Rosenkranz, 2010). Thus, the process can be considered an asset of the organization; it contributes to business performance when well managed. With regard to establishing BPM priorities and planning, MRO organizations can focus on customer value and clarify strategic decisions (Vom Brocke & Rosemann, 2007).

3 Case Study Description

The MRO facility of this case study is part of a global organization with other facilities worldwide. It operates with different customers and types of aircraft, which highlights the complexity of the service. Normally, the customer is an airline company that offers passenger or cargo transportation services. Customers request heavy maintenance tasks for their commercial aircraft from the MRO facility.

The airline customer's main request for MRO service is to operate according to quality standards and to deliver its aircraft on time with cost-efficient activities. In addition to the service performed at the aircraft, the airline company requires all documentation to guarantee that processes and heavy maintenance tasks are executed according to governmental regulations and contracts to maintain its airworthiness certification. This context enhances the product-centric service perspective of the MRO facility. Aircraft maintenance activities are the most crucial activities to ensure aircraft utilization and involve multiple services that the MRO company needs to offer to its client through the optimization of assets, manpower, resources, tools and partners (Jalil et al., 2017). **Figure 1** represents the relationship with airline customers and MRO facilities from a product-centric service perspective.

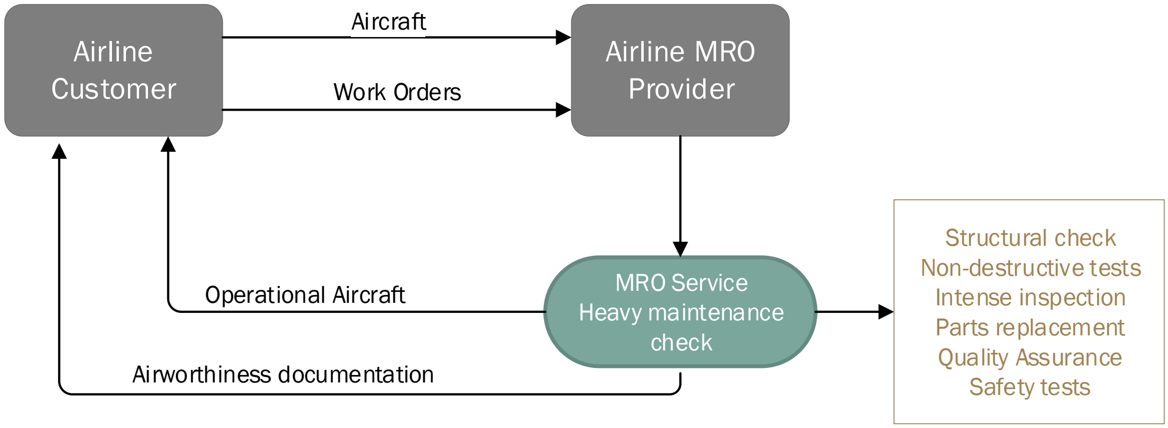

Figure 1: Interaction of MRO facility and airline customer

Each aircraft heavy maintenance project is composed of a variety of production activities and management operations. According to Goncalves and Kokkolaras (2018), the aircraft heavy maintenance check is composed of 4 phases: opening, inspection, rectification and final tests. Within the context of this study and to include a project management perspective, we included 2 phases of the heavy maintenance check project. Other studies have examined the project management aspect of a heavy maintenance check (Samaranayake & Kiridena, 2012; Soylu, 2017) to represent the uniqueness of each aircraft maintenance check and to show the potential of project management techniques.

In this paper, **Figure 2** was derived from the case study and illustrates the phases of the aircraft heavy maintenance project. Each phase represents a group of processes that deliver outputs for the subsequent phase. It is possible that the phases will change for different MRO facilities. Phase 1 represents the initial interaction between the MRO company and the customer, and planning management activities define maintenance operations with cost-hours activity. Phase 2 starts when the aircraft arrives in the hangar and panels are removed for the next phase. Phase 3 is when all inspection and operational test work orders are performed; therefore, this is the phase in which the discrepancies in work orders are identified (Goncalves & Kokkolaras, 2018). Phase 4 involves activities regarding discrepancies in work orders. Phase 5 involves the final tests and the last maintenance release of the aircraft. In this phase, quality assurance supports the official release of the aircraft from the hangar. Finally, Phase 6 involves all activities necessary for administrative closure. This includes the formal acceptance of aircraft deliverables and documentation, closing the project in the system, reassigning personnel and archiving project information for future needs. Other important activities of this phase, which are sometimes neglected, include recording lessons learned (success and failures) and managing knowledge sharing and transfer.

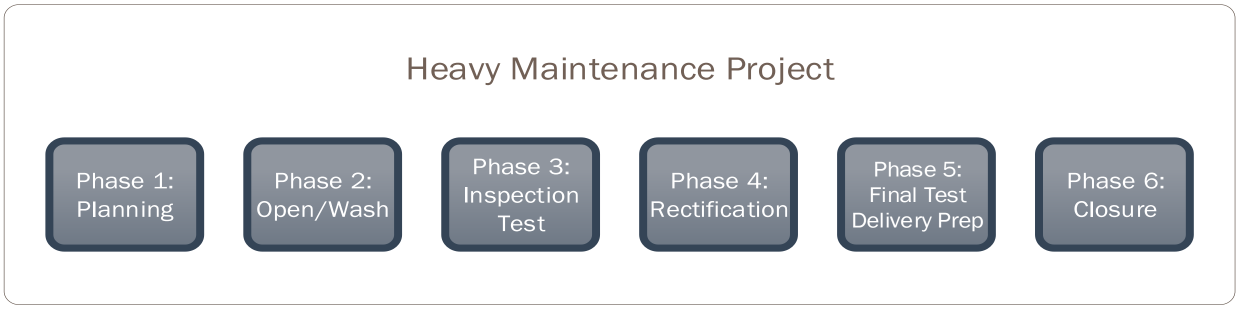

Figure 2: Conceptual representation of heavy maintenance project phases

The interaction between departments and customer requirements is an additional complication to the effectiveness and efficiency of heavy maintenance projects. Different customers may require additional tasks that were not initially planned, which may be related to production activities or service activities. Normally, this will require more time consumption for MRO activities and/or resource allocation.

4 Methodology

This paper conducted case study research on improving process management practices in the maintenance, repair, and overhaul (MRO) industry. BPM approaches are applied with an exploitation-oriented goal, which has the objective of achieving operational excellence, standardizing and integrating processes, and realizing incremental improvements (Rosemann, 2014). The processes analyzed in this paper are related to an aerospace MRO facility. Anonymity was requested by the facility; thus, the pseudonym MRO Inc. will be used to protect the identity of the company.

Business process management acts as a connection between top managers' decisions and operations activities. It is applied to increase the visibility of organization departments process (Fleacă & Fleacă, 2016) and their flexibility (Rosemann et al., 2008) and to increase understanding of a process as it is (Palma-Mendoza & Neailey, 2015). Business process management is a valuable tool to understand internal processes, work and communication flows, and interactions with customer processes.

This article applies a BPM approach in relation to the quality department process and its interaction with the core process of the organization. Because high-quality standards are required by maintenance operations, improvements in the quality assurance process to support business strategies are required. The challenge is that the quality process needs to consider governmental regulations, customer procedures and the maintenance policy of customers and MRO companies. Airline companies can use different strategies for maintenance policies, including adapting their management procedures to reduce delays and minimize the costs of maintenance (Gerdes, Scholz, & Galar, 2016; Regattieri, Giazzi, Gamberi, & Gamberini, 2015). Furthermore, the context of the MRO industry requires an adaptable and flexible quality process for customer preferences and requirements.

Improving the process in an organization should start from a deep knowledge of the current context, the reasons for improvement and the objectives to be achieved (Esposito et al., 2019). Accordingly, to choose the right BPM approach and objectives, this paper uses the framework proposed by vom Brocke, Zelt, and Schmiedel (2016) to develop a more context-sensitive BPM body of knowledge of the case study. We agree with the authors that the business context in which BPM is applied is a variable of where it will be applied. Thus, Vom Brocke et al. (2016) define the context in BPM based on four dimensions: the goal, process, organization, and environment. **Table 1** describes the four dimensions and the sub-categories of the framework. It will be used in this article to describe the specific context of the MRO Inc. facility.

Table 1. Context of BPM (Vom Brocke et al., 2016)

Contextual factors	Characteristics		
Goal dimension			
Focus	Exploitation (improvement)	Exploration (Innovation)	
Process dimension			
Value contribution	Support Process	Management Process	Core Process
Repetitiveness	Repetitive	Non-Repetitive	
Knowledge intensity	Low knowledge intensity	Medium knowledge intensity	High knowledge intensity
Creativity	Low creativity	Medium creativity	High creativity
Interdependence	Low interdependence	Medium interdependence	High interdependence
Variability	Low variability	Medium variability	High variability
Organization dimension			
Scope	Intra-organizational process	Inter-organizational process	
Industry	Product and service industry	Product industry	Service industry
Size	Start-up	Small and medium enterprise	Large organization
Culture	Culture highly supportive of BPM	Culture medium supportive of BPM	Culture non-supportive of BPM
Resources	Low organizational resources	Medium organizational resources	High organizational resources
Environment dimension			
Competitiveness	Low competitive environment	Medium competitive environment	High competitive environment
Uncertainty	Low environmental uncertainty	Medium environmental uncertainty	High environmental uncertainty

To develop an overall understanding of the MRO context, activities and functions, studies of the documentation and process manual of the company were combined with participant-observation techniques. These methodologies were conducted in other case studies (Borch & Batalden, 2014; de Souza et al., 2011; Esposito et al., 2019). Primary data collection involved the analysis of process manuals, company websites, information system documentation and standard procedure documentation used by the company regarding service and production activities. To obtain additional information, semi-structured interviews were conducted with different departments of the MRO facility. According to Yin (2016), non-verbal parts of the conversation between people, including tone of voice, interruptions, gestures, and actions, can also reveal insights.

The objective of the interviews was to understand the context of the MRO Inc. facility based on the four dimensions previously described. These interviews were important to gather data and insights about employees' perspectives on processes, organizational characteristics, culture, and customer interactions. Additionally, interviews were performed to understand important activities and the interaction of workflow information between departments of the organization that were not mapped in manuals or documents.

The interviews were conducted in groups or with individuals depending on company authorization and the department's schedule. The interviews were divided into two parts. First, general questions were asked about the dimensions of Table 1. The goal dimension was the focus of discussion with senior leaders of the MRO Inc. facility. Second, specific questions about process manuals and activities were asked. The questions varied depending on the process and activities. The aim was to identify tasks that were not represented in process manuals and documents and to capture tacit knowledge.

The data analysis was performed in two parts: 1) defining the context of the MRO Inc. facility according to the framework proposed by vom Brocke et al. (2016) and 2) using a BPM approach to increase service-oriented process management and process flexibility. Finally, we examined data from the documentation, interviews and participant observations in the field.

5 Analysis

5.1 Context: Business Process Management Flexibility in a Global Corporation

Each dimension was examined and considered to describe the organizational context of BPM in the company. The study case is a facility of a large MRO service corporation that performs heavy maintenance service for aircraft. To maintain market competitiveness, the MRO Inc. organization has been investing in methods to increase its performance in relation to customer satisfaction without losing its profit margins.

The company aims to find financial solutions for its services and improve efficiency for the customer. Furthermore, the MRO company aims to improve its processes by delivering personalized customer service with the highest standards of aircraft safety and quality. The competitiveness of the environment of MRO service has been increasing in recent years, and companies have begun to improve their performance with more advanced technology for data collection and measurement tools (Cooper, Smiley, Porter, & Precourt, 2017). In this study, we consider a medium-competitive environment. However, this context is already changing into a more highly competitive environment, as highlighted in the literature (Esposito et al., 2019; Vieira & Lavorato, 2016; Ward, McDonald, Morrison, Gaynor, & Nugent, 2010).

The goal of the BPM initiative is to improve activity performance to increase integration with internal function processes and customer support. The process under consideration is executed by the quality department, which must interact with and support production maintenance tasks and customer demands. It is a repetitive and highly knowledge-intensive process. Quality assurance is responsible for ensuring that maintenance activities are executed following airworthiness regulations. In addition to technical knowledge, quality teams are responsible for directly contacting customer representatives regarding maintenance program plans, quality, and safety information and specific customer demands. This process involves a low creativity level and is characterized by a high level of interdependence with other internal and external functions. The beginning of the MRO operations is marked by a quality assurance agreement signed by the MRO company and the customer. The terms can include changes in activities or even a new activity. These customization requests by the customer contribute to the variability of the quality process.

The MRO Inc. facility is able to invest a large number of resources in the standardization of the process; however, it needs the approval of the executives and top management of the organization. Through participant-observation interviews, it became clear that the top management of the organization is committed to improving the process and providing support when a structured proposition is presented. Although top management is supportive of processing management ideas, the directors of the MRO Inc. business units, middle managers and employees are less motivated to change and improve process capability through a systematic approach.

The interviews demonstrated the different levels of the facility of this study case. Employees are frustrated by unstructured changes in processes that occurred in the previous year at the company. In this context, each employee normally has his or her own way of performing the process, which can contribute to time consumption or customer complaints. Moreover, directors and middle managers do not realize the benefits of BPM approaches and process management in enhancing the performance results of the project. In this context, the culture of the MRO Inc. facility shows low support for BPM.

With regard to environmental uncertainty, heavy maintenance projects present high uncertainty with regard to discrepancies in operations. Phase 4 is characterized by the non-scheduled activities that emerged from phase 3 (**Figure 2**). Even if the planning management process can predict some operations that will emerge from the inspection work orders, there is always uncertainty about the resources that must be reallocated to perform tasks, including parts, tools, equipment or qualified technical personnel. Approximately 50% of the project's work orders are discrepancy activities that arrive for the inspection. This finding corroborates other studies (Gerdes et al., 2016; Goncalves & Kokkolaras, 2018).

Table 2 shows the contextual factors of the framework proposed by Vom Brocke et al. (2016) for the MRO Inc. facility. The framework was used as a tool to recognize and understand the context of BPM for goal, process, organizational and environmental dimensions.

Table 2. Context of BPM for MRO Inc

Contextual factors	Characteristics
Goal dimension	
Focus	Exploitation (improvement, compliance)
Process dimension	
Value contribution	Support process
Repetitiveness	Repetitive
Knowledge intensity	High knowledge intensity
Creativity	Low creativity
Interdependence	High interdependence
Variability	Medium variability
Organizational dimension	
Scope	Intra-organizational process
Industry	Product and service industry
Size	Large organization
Culture	Culture non-supportive of BPM
Resources	High organizational resources
Environmental dimension	
Competitiveness	Medium competitive environment
Uncertainty	High environmental uncertainty

The main reason for examining this scenario is to identify a better BPM methodology for the studied context. The focus of the organization is to ensure performance results through the exploitation of BPM goals. However, because the facility has a culture with low support for BPM, methods that will produce high levels of change are not recommended. The key factor in the success of BPM implementation is people's participation and a holistic management commitment though leadership and support (Buh et al., 2015; Fleacă & Fleacă, 2016; Škrinjar & Trkman, 2013). Therefore, according to the company's organizational context, innovative BPM approaches can interrupt the integration of business processes, contributing to a failure in BPM implementation.

The process dimension reflects the importance of a globally standardized technique that involves repetitive and low-creativity aspects. Its variability aims to support different customers and their unique demands regarding quality requirements. This can be accomplished through BPM approaches that consider flexibility an important parameter of the business process (Rosemann et al., 2008). It is also important to consider the high interdependence of the process with internal and external functions.

To create value and achieve business targets through business process management, BPM approaches that can help clarify tasks and produce the standardization of MRO activities are a favorable option. Standardization will decrease employees' frustration with process management techniques as defined by objectives and flow tasks. In addition, it will provide a tool for managers' decision-making regarding minimum cost decisions and flexibility for customer requests.

5.2 Business Process

Once the context of the organization and the goal focus was defined, it was necessary to understand the main activities and their interdependence. A business cross-functional process map technique was chosen to cover all tasks and functional activities for the work order process of the MRO Inc. facility as an investigative method (Palma-Mendoza & Neailey, 2015). This technique was chosen to increase the holistic vision of the interaction between cross-functional organization units in the process and to understand the workflow. The data used to describe the business process map are derived from participant observations and interviews.

Figure 3 shows the business process map. It is sectioned vertically according to the organizational unit responsible for the activity and horizontally into two aspects of the process: customer work orders and discrepancy work orders. The work orders are all operations activities requested by clients that mostly include inspection orders. All activities related to this phase are sent by the airline customer before the heavy maintenance project begins. Customers can request additional MRO service after the beginning of the project, which will require a signed agreement for the inclusion of the service.

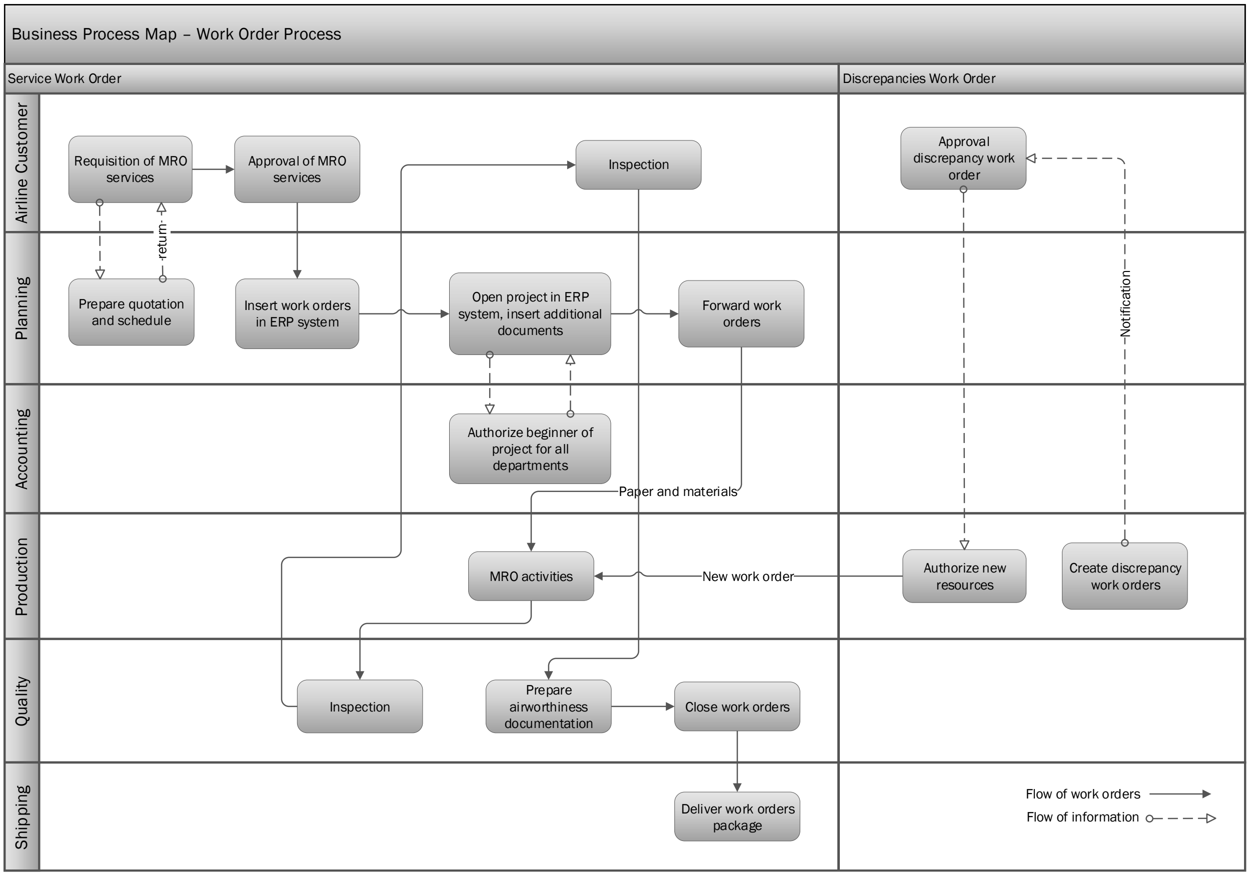

Figure 3: Business process map

According to **Figure 3**, quality organizational units are responsible for the inspection of work orders in accordance with airworthiness regulations, clients' requests and company processes. Quality assurance is an obligatory part of MRO service to ensure that all production activities comply with applicable federal regulations and aircraft engine maintenance manuals. It ensures that production activities do the right things in the right way (Transport Canada, 2017).

The differences in airworthiness authorities' regulations lead airline companies to accept different policies to minimize cost and ensure quality standards (Regattieri et al., 2015). Thus, the quality department is responsible for meeting customer requirements for airworthiness documentation. It is responsible for checking documentation regarding specifications for the continuous airworthiness maintenance program for customers. Normally, airline customers follow the requirements of airworthiness regulations; however, specific demands can be made. When a new customer contracts MRO activities, a quality agreement contract is signed to consider all exigencies for customer quality assurance services. To identify these activities, the methodology mentioned in section 3 was used. Company reports, quality contracts, the general maintenance manual, and the process manual were included in the preliminary analysis. Participant-observation techniques and interviews were conducted with a quality department team to understand the workflow for the work order process.

The analysis shows that different customer requirements significantly impact how the department performs its activities. Depending on customer requirements for the MRO quality assurance service, the tasks of the quality department are affected by time and cost. However, because the tasks are highly interdependent, operational activities may also change. The quality department is responsible for notifying the operations department of the different requirements of the client. For example, customers may require extra information for a specific maintenance operation activity, which must be made by a technical certificate employee. Some clients may ask to inspect major repair work orders before closing the work order service. This impacts new tasks before the closure of the aircraft maintenance project.

One weakness we found in the business process was the lack of integration of quality agreement and quality department activities. Coordinators and employees tend to execute the same activities for different clients or follow the same procedures as described by process manuals. However, these new or special activities are not considered in process manuals. Thus, new solutions must be developed as clients' complaints arrive. As tasks change in unplanned ways in the middle of activities, time-consuming tasks are inevitable. The additional tasks within the business process require overtime personnel or new personnel resources. The continuous and unprecedented changes in the process may lead to the need for process flexibility (Gebauer & Lee, 2008; Rosemann et al., 2008). We found that managers need to expand their knowledge about business processes and customers' requirements in a more systematic manner to adjust to new tasks to daily activities. Moreover, it is necessary to understand the goals and relations of the quality process. Quality department activities depend on the phase of the heavy maintenance project. Here, we focus only on tasks executed during phases 3 and 4.

The quality work order process has two main goals: 1. to check whether operation activities are performed according to quality and safety standards and 2. to deliver airworthiness documentation and services as required by customer procedures and governmental regulations. These goals are associated with the characteristics of a product-centric service company. To better understand these relations, Burlton's process scope diagram (Vom Brocke & Rosemann, 2007) was developed for the quality work order process (**Figure 4**)

Figure 4 presents the important inputs, guides, outputs and enablers of the quality process. The diagram includes the process as a service-oriented activity to achieve customer satisfaction, placed in the output box. Furthermore, as stated previously, the control of the process is based on many different guides and management policies, such as company manuals, federal regulations and the proper quality agreement, which emphasizes the importance of a process management technique that includes flexibility. The input of this process is the output of the production organizational unit process represented by all work orders and maintenance tasks.

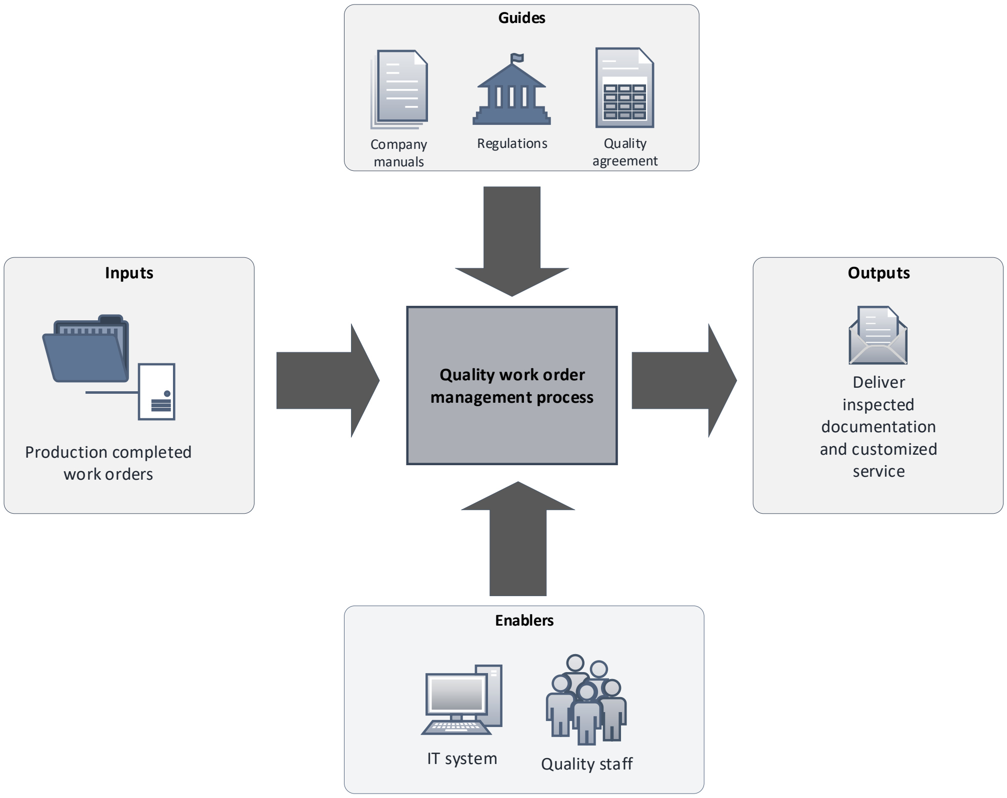

Figure 4 Quality process scope diagram

In this context, the business process modeling notation (BPMN) approach was chosen to guide the process flexibility of customer requirements and cross-functional roles. An alternative to the quality work order process was to map the main changes in requirements. The actual drivers of flexibility that were considered in this paper were related to airworthiness documentation. Although other changes can occur due to customer exigencies, requirements regarding documentation were recognized as a main issue from the quality department perspective. These changes affect the main activities of the department, increasing time consumption and manpower resources. **Table 3** presents the main requirements.

Table 3. Main customer requirements for quality

Quality documentation requirements	
1	Rotable and serviceable parts documentation
2	Quality assurance inspection and signature policy
3	On-site customer representative inspection
4	Airworthiness records and maintenance documentation

Figure 5 shows the sub-process map of the quality work order process and its interaction with the main customer requirements. Each requirement can change how the functional role performs its activities, either a new parallel activity as shown in number 1 or a completely different activity (numbers 3 and 4). Moreover, quality assurance inspection depends on the maintenance policy manual procedures of the company and customer, and it is presented in number 2 of the process map.

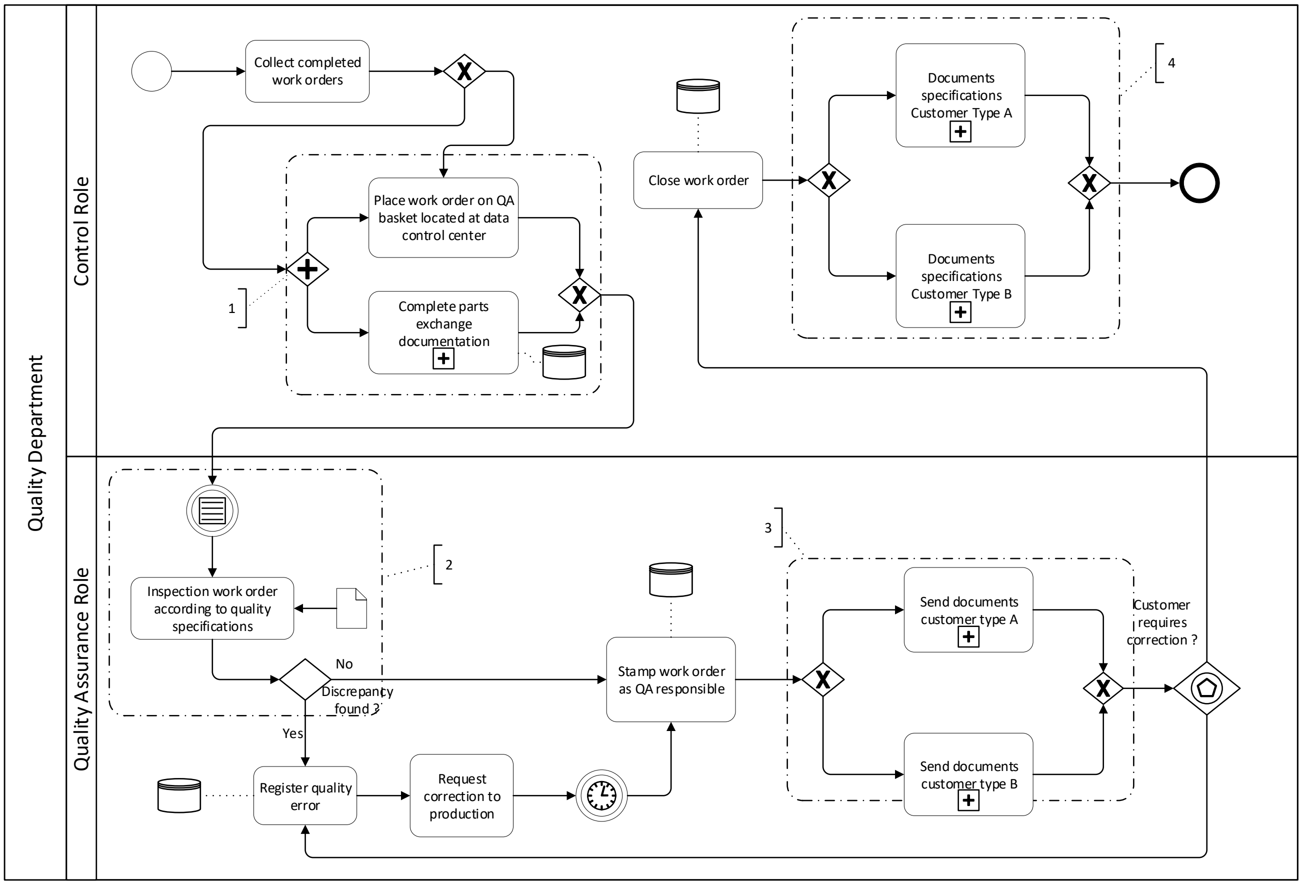

Figure 5: BPMN quality work order process

Changes will always be present on this type of process because new customers can arrive or a new regulation can be approved. Despite the type of change, the process must be able to absorb this change without completely replacing it. Thus, the most valuable information of the BPM map is to propose a tool to support changes regarding customer services through a flexibility process technique. Without process planning, bottlenecks are expected in the process, resulting in time consumption or customer dissatisfaction. Moreover, the BPM map provides a visual tool for decision-making by top managers for quality agreements with customer contract requirements.

6 Findings and Discussion

In this section, we discuss the findings of our analysis and the business process management literature. We examine the business process modelling context framework of vom Brocke et al. (2016) used in this study case to contribute to business process management. Moreover, we explore the importance of business process modelling to analyze the flow and interaction of cross-functional organization units. The results demonstrate a valuable use of the BPM context framework as a starting point for business process modelling decisions. The framework represents the foundation for examining the goals, process, organization and environmental context of the organization. In this regard, our research provides important insights into the examination of the BPM body of knowledge in a real environment.

The goal of the business process is crucial to align corporate strategic objectives and the operation level with business process modelling (Kerpedzhiev, König, Roeglinger, & Rosemann, 2017). Additionally, goal setting and operationalization can be interpreted as success factors for a BPM project (Lückmann & Feldmann, 2017). The senior managers of the MRO Inc. facility acknowledge their goals to ensure operational excellence with continuous improvement, which represents the exploitation goal of BPM. Thus, process orientation and standardization can be interesting strategies for maintenance operations.

According to the interviews and our observations, the organizational culture was the most important factor in our research. The case study demonstrates that personnel attempt to replicate actions each time; however, process documentation is rarely used, even for process changes. Moreover, the commitment of the top management and middle management of the MRO Inc. business unit was not present to support process standardization. The process should be considered an intangible asset of the enterprise (Fleacă & Fleacă, 2016) and not just a formal guide. These aspects contribute to a non-supportive culture of BPM. Research has previously recognized the impact of cultural aspects on the success of BPM and its value for achieving BPM objectives (Schmiedel et al., 2013; vom Brocke & Sinnl, 2011). In addition, top management support is crucial for business process orientation and implementation (Borch & Batalden, 2014; Škrinjar & Trkman, 2013). Convincing top management to continue as strong leadership has been a challenge for other study cases (Gazova, Papulova, & Papula, 2016; Kumar et al., 2015; Thomas et al., 2016). Analysis shows that top management needs to achieve a general consensus of process management strategies and goals.

The next relevant factors in process management approaches are the process and environmental dimensions. Close collaboration between departments is present as interdependence. By adopting BPM mapping approaches, activities between different departments and workflows can be easily understood. This can improve close monitoring and action for structured changes by managers. Because department goals need to be aligned with each other and the core process (Škrinjar & Trkman, 2013), this strategy provides a visible tool for managers and employees to increase reaction time and improve process management. The study case makes it clear that contextual factors contribute to examining the limits of the company and process characteristics in BPM implementation and application.

A business process modeling notation approach was selected after analysis of the BPM context of the MRO Inc. facility. The business process cross-functional role map can be used to empower departmental managers and employees to understand the entire process, surpassing individual knowledge of tasks (Škrinjar & Trkman, 2013). Because working in silos and a lack of integration are issues in MRO activities (Ucler & Gok, 2015), this can provide a holistic perspective on business processes in different departments and increase understanding of tasks. As shown in **Figure 3**, the approach captures department interactions and important gates to the work order workflow process. Thus, an intra-organizational process perspective can be introduced.

An additional purpose of the BPM approach is to increase the flexibility of the quality process according to customer demands. These demands can create interventions of new tasks that influence workflow and cost-time performance. To avoid bottlenecks, the early identification of necessary changes based on customer requirements is crucial for process management. Identifying the aspects of a process that are needed to change the process without completely replacing it can increase the flexibility of the business process (Rosemann et al., 2008).

The business process map of cross-functional roles presented in **Figure 5** provides a modelling approach to capture task flow while included the differences by customer. The map was constructed to incorporate flexibility into the process to improve performance results with regard to time consumption and customer satisfaction. A relevant issue may be the incorporation of the variability of activities on a process map through a holistic view with a well-defined objective of flexibility. This means that the exploitation goal can be achieved by increasing process management performance. On the other hand, the business process is linked to people's participation and commitment. Interviews performed to map the process demonstrated that personnel were interested in contributing. In fact, employees were enthusiastic about process mapping. When a map was presented, positive feedback was received by employees. We can conclude that a process map can contribute to personnel's sense of contribution and decrease the frustration of process changes. BPM implementation was not within the scope of this research. However, as mentioned previously, top management support is essential for the success of this application.

7 Conclusion

The product-centric service organization definition of the aviation MRO involves some challenges for MRO business process management strategies. It generates the need for an understanding of production-oriented and service-oriented functions to achieve strategic goals. In this article, we modeled a service-oriented process of an MRO facility to increase process flexibility and customer satisfaction with heavy maintenance activities. To accomplish the objective of this research, a case study was conducted with participant-observation and interview techniques. First, the framework proposed by Vom Brocke et al. (2016) was used to understand the organization’s context of BPM. Relevant information on the organization was extracted from this initial analysis to choose a BPM approach.

A BPM map was chosen as a tool to improve the process perspective on cross-functional activities through workflow task standardization and information flow in organizational units. Quality management is a complex system for MRO companies because it is responsible for achieving regulation requirements and customers’ special demands. The work order quality assurance process was detailed to include different customer requests without the need for constant process changes as observed at the MRO facility. Our study demonstrates the usefulness of process management to increase process flexibility in an MRO service-oriented activity because of the importance of quality assurance tasks and the integration of customer demands on the system without compromising performance. It has been observed that MRO organizations are improving their process to continue in the market. This paper presents a process management approach to constantly improve current quality maintenance tasks and adapt to the demands of the sector.

The main managerial implication is that business process management approaches can be used to improve the limited cross-functional perspective to a holistic view. Additionally, the use of the BPM approach is a valuable tool to increase performance results for product-centric service companies, especially to establish the objectives as well as the individual tasks of the process. This study has shown that understanding the process context may be crucial to the choice of the BPM approach. Accordingly, the business process management approach can be a tool for decision-making by managers and to better understand workflow issues related to the integration of customer requirements and process activities. In addition, efficient process management requires support for top management and personnel participation.

A contribution to the body of knowledge on BPM lies in recognizing the benefits of an understanding of the goal, process, organizational and environmental factors of the BPM context in a company. In particular, these factors contribute to the selection of an appropriate process management technique for the study case. Furthermore, business process map approaches can be an interesting alternative to increasing process flexibility as well as a customer service-oriented perspective for a product-centric company. This research contributes to customer process integration and value-driven process maps with a study case perspective.

Concerning the contextual framework used in this research, we are aware that is not a complete framework (vom Brocke et al., 2016). Other factors may influence the BPM body of knowledge of the industry. We chose to use the framework as an initial analysis of the goal, process, environmental, and organizational dimensions of the business process context of this study case. Some of these factors are also crucial for total quality management or lean culture implementation. The importance of knowledge of these dimensions became obvious as our analysis progressed. This knowledge influences the effectiveness of business process modeling approaches (vom Brocke & Sinnl, 2011; vom Brocke et al., 2016). Further research can examine other factors, including knowledge management and the level of technology required for the process.

We consider BPM approaches a valuable tool in process management because customer demands can be highly variable in this scenario. To better integrate these changes without replacing an entire process, we propose the examination of customer demands as external factors of process activities and their inclusion in process representation. Additionally, analysis of the main characteristics of the process is crucial to clarify objectives. We argue that business process maps will increase employees' and managers' process orientation as well as change decisions. They can help organizational levels operate in a more structured manner. Therefore, the BPM approach can be adapted to identify and monitor customer requests and possible changes.

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