

The promotion of BPM and lean in the health sector: main results

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Abstract

Purpose – Given the complexity and difficulties of the health sector, the question that this study attempts to answer is as follows: what are the main results of studies on business process management (BPM) and lean in the health sector? The purpose of this paper is to analyze the results of studies that address the promotion of BPM and lean in the health sector.

Design/methodology/approach – To conduct a survey of published studies using the BPM and lean approach in healthcare, a search was performed in the Scopus, Web of Science, and PubMed databases in two steps. The first step consisted of the collection and analysis of data related to the BPM approach in the health sector, based on a survey of published articles on this topic. The second step consisted of the collection and analysis of data related to the use of lean in the same sector, based on the survey of systematic reviews published in major databases.

Findings – The main results of the studies that address the promotion of BPM and lean in the health sector are as follows: a reduced length of hospitalization, increased patient satisfaction, increased patient efficiency and safety, a reduction in the time of notification of infection, help with organizational change, understanding the end-to-end process, increased motivation, understanding the importance of some handoffs for patient safety, improvements in quality indicators in the emergency department, and improvements in the organization's focus on high-level processes. By contrast, a single study showed difficulties in promoting management focused on processes in which decisions are unique and difficult to model.

Originality/value – The results may help in the identification of research gaps in the promotion of BPM and lean healthcare and in the development of relevant research. In addition, by understanding how health organizations are promoting management focused on processes and the results obtained with this approach, managers from other organizations, especially in this sector, can reflect and develop similar actions that seek to improve the quality of services offered, increase productivity and customer satisfaction, and reduce costs, errors, and waiting times.

Keywords Lean, Business process management, Process management, Lean healthcare

Paper type Literature review

Introduction

Business process management (BPM) is derived from the combination of two approaches to improving performance, Six Sigma and business process reengineering, resulting in an integrated business performance management system focused on managing business processes from end-to-end (Hammer, 2010). This is a new way of viewing business operations, unlike the traditional view of functional structures based on the orchestration of activities in business functions (Paim *et al.*, 2008). BPM emerged from process orientation, in which organizations began to focus their business processes on the customer instead of emphasizing functional and hierarchic structures (Reijers, 2006).



These organizational goals can be achieved with the aid of managing processes focused on delivering customer value (Maddern *et al.*, 2013). In this context, the lean method, which is also focused on value, is approached in BPM as one of the different knowledge sets, mainly applied to the transformation of processes aimed at reducing waste (Association of Business Process Management Professionals (ABPMP) – Brasil, 2013). Thus, it is a supporting technique that includes a set of useful tools for improving processes and consequently the delivery of greater value to customers.

Improving organizational efficiency requires a constant focus on improving key processes and knowledge management (Bitkowska, 2015). Lean principles are currently known worldwide, and applications reach well beyond the production of goods to include service and healthcare delivery (Brandão de Souza, 2009). Initiatives to improve business processes are often confused with BPM, but they relate to specific improvements and culminate in a set of improvements to be implemented. However, the use of these approaches does not imply that the organization is committed to the practice of BPM (ABPMP, 2013).

Lean has been widely applied in the health sector independently of BPM. This application is sporadic and targeted at solving specific problems (Mazzocato *et al.*, 2010). Thus, the overall strategic vision addressed by BPM has been suppressed by the current use of the lean approach in healthcare, contrary to that proposed by Womack and Jones (2003). Improving the management of business processes is a growing concern and a critical success factor for healthcare organizations (Rebuge and Ferreira, 2012) that are looking for methods to streamline processes to deliver high-quality services while reducing costs (Yarmohammadian *et al.*, 2014). These organizations are generally characterized by a large number of medical disciplines and specialized departments, making their processes dependent on interdisciplinary cooperation and coordination. For this reason, it is very difficult to understand how things are connected and how these interactions work (Sturmberg and Martin, 2013). The healthcare industry has had trouble dealing with a dynamic environment, diversifying wisely, keeping costs down, and balancing capacity and demand (Ginter *et al.*, 2013). In this type of environment, it is crucial to optimize processes (Lenz and Reichert, 2007) and also to orchestrate the activities of the various functions.

In the health sector, processes should be viewed as a way to control the use of technology and to create patterns of therapies that are defined based on the diagnosis of patients. The promotion of BPM can reduce costs, improve information integration, improve the safety and quality of patient care, and improve the work routine of health professionals (Becker *et al.*, 2007). However, in this sector, most of the decisions are complex and unique and generally relate to the tacit knowledge of experts (Manfreda *et al.*, 2014). An environment is usually considered complex if it is made up of several closely connected parts; the more parts and the more connections are entwined within an organization, the more complex it is and the more difficult it is to analyze (Sturmberg and Martin, 2013). The health sector is characterized by being highly complex, dynamic, specialized, and multidisciplinary (Kirchmer *et al.*, 2013).

Due to the sector's complexity, with processes involving both clinical and administrative tasks and a high volume of data as well as patients and professionals, organizations may find it difficult to improve their performance and increase their efficiency (Yarmohammadian *et al.*, 2014). Given the sector's complexity and difficulties, this paper seeks to answer the following question: what are the main results of studies on BPM and lean in the health sector? The objective of this study is to analyze the results of studies that address the promotion of BPM and lean in the health sector.

This study can help managers of health organizations understand which practices and approaches may be useful in simplifying processes and in offering high-quality services and reducing costs responsibly. Process management is a critical success factor for healthcare

organizations (Rebuge and Ferreira, 2012), and simplification is important to provide high-quality services while reducing costs (Yarmohammadian *et al.*, 2014). This study may help researchers seeking innovation in the processes of healthcare organizations to orchestrate many functions of various departments and specialized medical disciplines.

BPM

A business process is a set of interdependent activities or tasks organized to achieve specific business goals, involving various functional structures and hierarchies (Bitkowska, 2015). Process management operates in an end-to-end fashion, from the initial customer request to customer fulfilment (Maddern *et al.*, 2013). To manage these processes, BPM, which is a way of articulating and applying methodologies, approaches, and tools in an integrated manner for processes generally applied alone, should be promoted. It is a holistic view of organizing, structuring, and conducting business. Given that BPM enables quick adaptation to change, this approach has become one of the most important issues in the area of management (Neubauer, 2009).

The promotion of BPM provides a change in the organization's view by leading the organization to have an "outside in" perspective, in which customers are the focus of the process (Burlton, 2010). This change is important for the organization's efficiency, given that, in the traditional view, in which the company is organized by functional structures or departments, functional managers often develop plans that ignore the needs of their peers and the importance of delivering maximum value to the customer. These managers often end up focused on internal processes and do not realize that what matters to customers is not what occurs in the domestic environment but the product and/or service offered (Burlton, 2010).

In this approach, to increase business efficiency and deliver more value to the customer, the activities of processes can be classified as activities that add value, activities that do not add value, and control activities (Chircu *et al.*, 2013). The activities that add value produce value or contribute to customer satisfaction or to ensuring compliance with policies and regulations, whereas those that do not add value are often unnecessary and contribute to increased time, costs, errors, and customer dissatisfaction.

BPM provides many benefits to organizations because it generally allows businesses to create high-performance processes, resulting in higher speed, lower costs, improved asset utilization, and greater flexibility, in addition to helping companies better react to periods of rapid change (Hammer, 2010).

BPM enables the organization to understand its processes, which can help managers redesign workflows to make them more efficient and effective and to reduce unnecessary costs (Cannavacciuolo *et al.*, 2015). BPM can also assist in the implementation of a strategic program to improve the fit between the organizational strategy and the organization's business processes (Trkman, 2010). BPM is a dynamic capability that the organization can have, a set of techniques to integrate, build, and reconfigure the organization's business processes to achieve a fit with the market environment (Niehaves *et al.*, 2014). Process standardization significantly impacts process performance in general and process time, cost, and quality in particular (Münstermann *et al.*, 2010).

A point of vulnerability in the processes, which can result in disconnections and hinder efficiency, is called a handoff. Handoffs are the points in processes in which information or work is transferred, going from one function to another. Cohen and Hilligoss (2010) presented this concept in the context of the health sector; according to these authors, a handoff is the exchange of information on a patient conducted among health professionals with the transfer of control or responsibility over the patient. This makes handoffs sources of great opportunity for process improvement and should thus be reduced (Spanyi, 2010).

To identify opportunities for process improvements, the first step is to create a common understanding of the current state (“as-is”) of the process, which can be achieved through the analysis of the process. This analysis is performed by obtaining relevant information, mainly related to customer interactions, handoffs, bottlenecks, changes, cost, and human involvement, which can be obtained through the following questions (ABPMP, 2013):

- (1) Interaction with customers – generally, the lower the number of interactions with the customer is, the more satisfied the customer is:
 - Who is the customer? What are the customer’s needs and complaints?
 - What is the number of interactions between the customer and the process? Are there redundancies in the interactions?
 - What are the metrics of customer satisfaction? What are the customer’s expectations of the process?
- (2) Handoffs – typically, the lower the number of handoffs is, the lower the vulnerability of the process:
 - What handoffs are more likely to delay the process?
 - Is a handoff creating bottlenecks in information and services?
 - Can the handoffs be eliminated? Is the interval between handoffs being measured?
- (3) Bottlenecks – limitations in the process that create work accumulation:
 - What factors contribute to the bottleneck (people, systems, infrastructure)?
 - Is the bottleneck the result of a handoff or lack of information?
 - Is the bottleneck being created due to resource constraints (human, equipment, rules)?
- (4) Variations – slows down the process and requires more resources:
 - What is the tolerable limit of variation for the process?
 - Is variation necessary or desirable?
 - What are the points of greatest occurrence?
 - Can automation help eliminate?
- (5) Cost – understanding costs helps prioritize processes:
 - What is the total cost of the process?
 - Is it in line with the industry standard?
 - Can it be reduced by automation or technological improvements?
- (6) Human involvement – activities performed by people are more complex because they involve knowledge and judgments that cannot be automated:
 - How much variability is introduced by human involvement? Can some activities be automated?
 - How much information is available to perform the activity? Is it sufficient?
 - Do those in charge of implementation know when the job was well done and where it fits into the process?

In health organizations, processes are complex and often fragmented between departments because they are organized based on medical specialties or skills, leading to difficulties in

the coordination and control of activities and affecting the quality and efficiency of the services offered to patients (Gonçalves *et al.*, 2013). Promoting BPM in the health sector may be useful in improving the quality of the services offered to patients. This approach assists in the coordination process because it involves end-to-end work (Maddern *et al.*, 2013) and the orchestration of processes (Burlton, 2010) and aims to improve and manage business processes to provide maximum value to the customer (Trkman *et al.*, 2015).

In this context, lean is approached in BPM as one of the different knowledge sets mainly applied to transformation of processes to reduce waste (ABPMP, 2013). In this manner, it is a supporting technique that includes a set of useful tools for improving processes and consequently the delivery of greater value to customers. It is an approach to improving processes that is inserted into activities involving the promotion of BPM: define organization objectives; identify organizational processes; classify processes: rank processes according to contribution criteria for organizational objectives, providing related benchmarks and potential for financial improvement; choose the process that has the best contribution; determine the use of the most appropriate tool, whether it is for incremental or radical change; implementation of the improvement project; and process monitoring (Verma, 2009).

Origins and definition of lean healthcare

Lean thinking is defined as a philosophy whose principles, tools, and methods aim to reduce waste (which does not add value for the customer) and improve quality (Dellifraigne *et al.*, 2010). Moraros *et al.* (2016) considered providing value for the consumer and eliminating waste the focus of lean thinking. Processes are defined according to what consumers want, and then, the organization determines which activities add value and which do not. There are seven sources of waste: overproduction, waiting, over-processing, inventory management, movement, transportation, and defects (Ohno, 1988).

Lean thinking was originally developed for Toyota's automotive sector in Japan after the Second World War, which explains why it was called the Toyota Production System (TPS); hereafter, it is called lean thinking. This methodology was born from the observation that the mass-production system could be improved through experiments focused on eliminating waste and the creation of multi-tasking teams, which not only produced but were also empowered to inspect and improve their own work (Womack *et al.*, 2007). Lean thinking is based on two pillars proposed by Taiichi Ohno, who is considered the father of the TPS: just in time, which includes the implementation of demand-pull and zero stock, and automation, which includes automatic stop mechanisms and fool-proof (*poka yoke*) systems (Ohno, 1988).

Womack and Jones (2003) proposed the application of lean thinking to any type of activity using a five-step model. The first step is identifying the value for the end consumer. For Womack and Jones (2003), value is represented by products, services, or both, with specific capabilities and prices. Therefore, based on the definition of value for the end consumer, a value map is constructed, i.e. there is an evaluation of all actions required to deliver a specific service or product to the customer. This analysis enables identifying the set of steps that add value as well as the activities that do not add value and must thus be eliminated. The elimination of waste allows value to fluctuate continuously through the process with minimal delay. Next, demand-pull is established by the consumer and is aided by a visual signaling system (*kanban*) that indicates the need for new materials or products in subsequent steps. The implementation of lean thinking ends with a process of continuous improvement or search for perfection. Thus, the previous steps must be constantly performed to reduce waste and improve quality (Holden, 2011).

Ohno (1988) believed in the adaptability of lean thinking to any type of business, as did Womack and Jones (2003), who specified the applicability of this approach to health services. Thus, after its success in the automotive industry, lean thinking was adopted by other

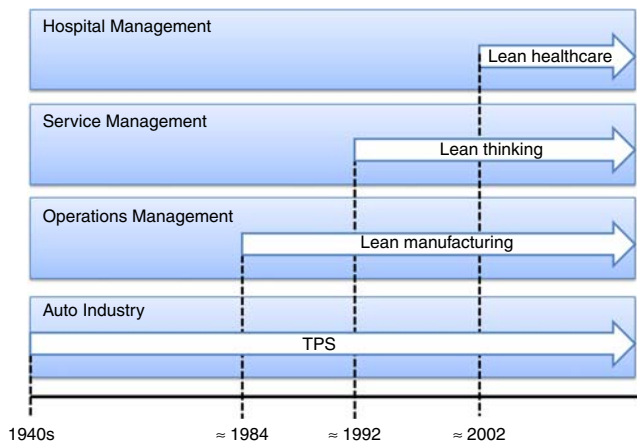
industries and services, including the health sector. For instance, it was widely implemented by the UK National Health Service, the UK's public health system (Holden, 2011).

Al-Araidah *et al.* (2010) confirmed that the lean thinking principles have been successfully adapted to the healthcare setting, enabling hospitals to simplify their operations and focus on the value perceived by the patients. Brandão de Souza (2009) defined this use in health services as an improvement approach that consists of the elimination of waste to improve the flow of patients, information, or goods. Thus, the application of lean thinking in the healthcare sector has become known as lean healthcare. Figure 1 shows the evolution of the methodology from Toyotism in 1940 to Lean healthcare in 2002.

Methodological procedures

To analyze how studies on BPM and lean developed in healthcare approach process management, a literature review was conducted using published references available in databases. Therefore, this research is classified as descriptive and qualitative. The literature review was conducted based on the definition of search expressions, database selection, selection of the years of publication, surveys of studies, and data analysis.

The survey was conducted in two steps. The first consisted of collecting and analyzing data relating to the BPM approach in the health sector based on a survey of published articles relating to the topic. The second consisted of collecting and analyzing data relating to the use of the lean approach in the same sector based on a survey of systematic reviews published in major databases. The two steps were structured according to the method proposed by vom Brocke *et al.* (2009) for literature review studies. According to the authors, this type of study should be conducted in five steps: (I) definition of the review's scope; (II) conceptualization of the topic; (III) literature search; (IV) literature analysis and synthesis; and (V) research agenda. The scope (I) of this study was defined as a synthesis of literature addressing BPM and lean thinking in the health sector focusing on the promotion of these approaches. The conceptualization of the topic (II) and the literature search (III) are described in the section "Data Collection and Processing." The literature analysis and synthesis (IV) are discussed in the "Results" and "Discussion" sections, and the research agenda (V) is described in the section "Conclusions and Research Agenda." Table I shows the protocol adopted for this study.



Source: Laursen *et al.* (2003) and Brandão de Souza (2009, p. 123)

Figure 1.
Historical evolution
of lean healthcare

Table I.
Research protocol

Study question	What are the main results of studies in the health sector that address BPM and Lean?
<i>Analysis unit</i>	
Database	Web of Science, Scopus and PubMed
Time limit	Prior to September 2016
<i>Strings</i>	
First step	“Business Process Management” AND “healthcare”
Second step	“Lean healthcare” and “review”
Construct validity	Comparison between theory and results of empirical studies
Elementary research issues	What gains are identified in studies analyzing the promotion of BPM in the health sector? What gains are identified in systematic reviews addressing lean in the health sector
Sources: The authors. Data Collection and Processing	

To conduct the survey of published studies using the BPM and lean approach in health, a search was conducted in the Scopus, Web of Science, and PubMed databases. These databases were used in both stages of the study. As a search strategy, two combined expressions were used in the first step: “BPM” AND “healthcare.” In the second, the expressions used were “lean healthcare” and “review.” The filters were used in both stages so that these terms were located only in the “title, abstract, or keywords.”

The search term “BPM” was chosen due to its wider applicability BPM is an approach employed to manage processes in an integrated manner using methodologies, approaches, and tools that are commonly used alone. The term BPM is used consistently to describe the previously defined concept (Trkman, 2010). Therefore, it is believed that the vast majority of studies addressing process management, irrespective of the tool used, employ this term at some point. “Healthcare” was selected as a search term due to its constant use in studies of the health sector, which is the subject of this study.

In the first step, related to the use of BPM, we selected all journal articles published prior to September 2016. In the second, because there are several systematic review studies on the use of lean thinking in healthcare, we decided to conduct a tertiary systematic review. According to Hochrein *et al.* (2015), research in general can be divided into three categories: primary studies involve independent research that may be based on newly collected data such as theoretical and conceptual articles and empirical surveys; secondary studies gather the discoveries of a certain field of research in the form of a narrative literature review, systematic literature review, or meta-analysis; and tertiary studies consolidate the results of primary studies that have been reported in secondary studies. Kitchenham (2007) defined the systematic review of tertiary studies as a systematic review of systematic reviews, and recommended that this method be used in fields for which there are already a number of published systematic reviews, as is obviously the case with lean healthcare. The merits of this method are that it is possible to analyze the contents of different literature reviews and answer broader research questions as well as condensing the different content explored in these articles into a single paper. The use of the search strings “Lean healthcare” and “review” summarizes the type of studies sought by this overview of the literature; thus, “review” was used to include literature reviews, whereas “Lean healthcare” was used to select articles on this subject. These broad search terms were chosen to avoid excluding articles due to an overly narrow definition of the search strings. Therefore, we also avoided placing a time restriction on the studies and used all years prior to September 2016.

The exclusion criteria used in the first step were as follows: articles that were not classified as a journal article, articles that did not have the full text available in the databases studied, and works that did not directly discuss the promotion of BPM in the health sector in the first case. In the second step, which related to lean healthcare, the exclusion criteria used were as follows: articles that did not refer to systematic reviews on

lean healthcare, articles whose full text was not available in the databases studied, and articles written in a language other than English and Spanish were excluded in both steps.

The articles selected in the first step, after the exclusion criteria were applied, were initially organized into a table with the title, author, year, and journal. Next, a second table was constructed with the main information of each of the organizations: the identification of the article (title and authors); the study's objective; the method used and the results. In this manner, it was possible to identify the main results of studies in the health sector that used the BPM approach.

In the second step, related to the search for systematic reviews of lean, a table was also built with information on the title, author, year, and journal of each article selected.

In this step, a table with information on the objective and method would not make sense because all articles involved in the study use the systematic review method in their studies. The analysis of the articles surveyed in the lean stage was performed to answer specific questions, such as the origin, use, and results obtained with the use of lean healthcare, to verify the main findings and studies in this sector.

After the completion of these two steps, based on the results of each analyzed study, categories for overall gains were created based on the specific gains observed in these studies. Each specific gain inherent to each study was placed in a broader category based on similarity. Gains such as reduced patient waiting time, reduced time spent by nurses in activities that do not add value, reduced time for the delivery of test results by laboratories, and reduced time for resolving error warnings were assigned to the "Time reduction" category. Similarly, all gains relating to cost and error reduction were assigned to these categories. This categorization scheme allows the study results to be presented in a more objective and comprehensive manner, which facilitates comparison with similar studies. Given that some of the reported gains were very specific, they were classified into 11 broader categories: mortality, costs, time, errors, profit, customer satisfaction, employee satisfaction, productivity, service level, patient safety, and "did not measure gains." A matrix of the resulting categories is presented in Table II.

After the results category matrix was created, a comparison matrix was constructed following Webster and Watson (2002) to present the gains found in the studies selected in steps 1 and 2.

The categories mortality, costs, time, and errors included the studies that reported gains achieved through a decrease in those items as a result of the promotion of BPM or lean healthcare. The categories profit, customer satisfaction, employee satisfaction, service level, and patient safety included the studies that reported gains resulting from an increase in those items. The category "did not measure gains" included the studies whose objectives did not include the measurement of the gains resulting from the promotion of BPM or lean healthcare. The goal of this matrix was to summarize findings and enable a comparative analysis of the main gains reported in the selected studies.

Results related to BPM and healthcare

In the first step of the study, which used the terms BPM and healthcare, 54 articles were initially found, including 26 in Scopus, 14 in Web of Science, and 14 in PubMed. After the first analysis of the titles and authors, 12 articles were excluded because they were duplicates, 1 because it was not a journal article, and 12 because they were not available in searchable databases, which left 30 for reading. Of these, 20 were excluded after the abstract and introduction were read because they focused on the development of information and communication systems. Ten articles remained for full analysis in this study (Table III).

The results, including information on the title, objective, method, discussion, and results of these studies, are organized and summarized in Table IV.

Category	BPM	Lean
<i>Decrease</i>		
Mortality		Mazzocato <i>et al.</i> (2010)
Cost	Graeber <i>et al.</i> (2007), Leu and Huang (2011)	Brandão de Souza (2009), Vest and Gamm (2009), Mazzocato <i>et al.</i> (2010), Poksinska (2010), Dellifraire <i>et al.</i> (2010)
Time	Graeber <i>et al.</i> (2007), Janiesch and Fischer (2009), Leu and Huang (2011)	Young and McClean (2008), Brandão de Souza (2009), Mazzocato <i>et al.</i> (2010), Poksinska (2010), Dellifraire <i>et al.</i> (2010), Holden (2011), Nicolay <i>et al.</i> (2012)
Error	Chircu <i>et al.</i> (2013)	Brandão de Souza (2009), Mazzocato <i>et al.</i> (2010), Poksinska (2010), Dellifraire <i>et al.</i> (2010)
<i>Increase</i>		
Profit		Young and McClean (2008), Brandão de Souza (2009)
Customer satisfaction	Nariño <i>et al.</i> (2013)	Brandão de Souza (2009), Vest and Gamm (2009), Mazzocato <i>et al.</i> (2010), Poksinska (2010), Dellifraire <i>et al.</i> (2010), Nicolay <i>et al.</i> (2012)
Employee satisfaction	Graeber <i>et al.</i> (2007), Sanchez <i>et al.</i> (2008)	Brandão de Souza (2009), Poksinska (2010), Brackett <i>et al.</i> (2013)
Productivity/efficiency	Janiesch and Fischer (2009), Yarmohammadian <i>et al.</i> (2014)	Young and McClean (2008), Brandão de Souza (2009), Mazzocato <i>et al.</i> (2010), Poksinska (2010), Dellifraire <i>et al.</i> (2010), Holden (2011), Nicolay <i>et al.</i> (2012), Brackett <i>et al.</i> (2013)
Service level	Janiesch and Fischer (2009), Leu and Huang (2011), Nariño <i>et al.</i> (2013)	Brandão de Souza (2009), Mazzocato <i>et al.</i> (2010)
Patient safety	Janiesch and Fischer (2009)	Young and McClean (2008), Brandão de Souza (2009), Vest and Gamm (2009), Nicolay <i>et al.</i> (2012), Brackett <i>et al.</i> (2013)

Table II.
Category matrix

In the study by Graeber *et al.* (2007), pathways were implemented in the general surgery department in a university hospital in Germany through BPM methods. The authors developed, implemented, and tested these pathways. The test was performed by comparing the care of patients before and after the implementation of the pathways. The authors concluded that there was a reduction in cost and effort and an improvement in patient satisfaction.

Janiesch and Fischer (2009) conducted a case study to show how BPM and information technology help reduce the frequency of human errors in health. The current process of hospital infection control was constructed by using “as-is” analysis, and improvements were then suggested in the existing workflow based on a to-be design. The authors concluded that, after the implementation of the improvements, there was a reduction in the average time of patient notification following infection from 70 to 17 hours and therefore an increase in efficiency, quality improvement, and patient safety.

Sanchez *et al.* (2008) used the Architecture of Integrated Information Systems (ARIS) methodology, based on BPM, to develop a speech recognition system in a hospital in Spain. They concluded that the BPM approach increases the satisfaction of those involved in the implementation of the system, in this case, the clinical teams, because it allows those involved to better understand the units in which they work by actively participating in modeling processes.

Manfreda *et al.* (2014) conducted a longitudinal case study in a public European health insurance company. The goal was to identify the factors that increase the absorption capacity in a BPM project, analyzing the role of business process modeling as a method of increasing this capacity. The authors concluded that the factors that increase this capacity are the presentation of the details of the methodology to those involved in the

Title	Author	Year	Journal
Clinical pathways in general surgery	Graeber <i>et al.</i>	2007	<i>Methods of Information in Medicine</i>
Application of business process management to drive the deployment of a speech recognition system in a healthcare organization	Sanchez <i>et al.</i>	2008	<i>eHealth Beyond the Horizon – Get IT There</i>
Information system and healthcare XXXI: improving infection control process efficiency to reduce hospital acquired infections	Janiesch and Fischer	2009	<i>Communications of the Association for Information Systems</i>
An application of business process method to the clinical efficiency of hospital	Leu and Huang	2011	<i>Journal of Medical Systems</i>
Medication errors, handoff processes and information quality: a community hospital case study	Chircu <i>et al.</i>	2013	<i>Business Process Management Journal</i>
Inserción de la gestión por procesos en instituciones hospitalarias: concepción metodológica y práctica (Insertion of business process management in health care organizations: methodological and practical conception)	Nariño <i>et al.</i>	2013	<i>Revista de Administração</i>
Absorptive capacity as a precondition for business process improvement	Manfreda <i>et al.</i>	2014	<i>Journal of Computer Information Systems</i>
Improvement of hospital processes through business process management in Qaem Teaching Hospital: a work in progress	Yarmohammadian <i>et al.</i>	2014	<i>Journal of Education and Health Promotion</i>
Developing an evaluation framework for clinical redesign programs: lessons learnt	Samaranayake <i>et al.</i>	2016	<i>Journal of Health Organization and Management</i>
Combining modeling and simulation approaches	Bisogno <i>et al.</i>	2016	<i>Business Process Management Journal</i>

Source: Developed by the authors

Table III.
List of articles
selected in the first
step of the study

implementation of the project, the correct identification of key processes, the day-to-day use of the language from the projects, and active employee participation. The barriers identified were the public sector, in which the project was developed and in which it is difficult to eliminate or change projects that do not add value and positions are typically held by health professionals and not by managers.

Chircu *et al.* (2013) analyzed how handoffs, that is, the transfer of information and responsibility among professionals, contribute to medication errors by impacting information quality during patient hospitalization. The authors concluded that a process with many handoffs can lead to medication errors due to the spread of incomplete, inaccurate, hasty, or invalid information; however, by contrast, they can also help reduce these errors. The authors claimed that this reduction in errors can occur because there is a greater probability of detecting errors when information goes through several different individuals.

Leu and Huang (2011) sought to understand the feasibility of promoting BPM in healthcare organizations seeking to improve the quality of medical service. The authors noted that three indicators of quality of care improved after the promotion of BPM and thus concluded that the care of the hospital emergency department, in which the study was conducted, improved and that its efficiency increased. The indicators analyzed in this study were the following: the number of remaining observations, the bed occupancy rate, and nursing hours.

The remaining number of observations and the bed occupancy rate indicate the number of patients who are undergoing observation in the emergency department. When the

Article	Objective	Method	Results
Clinical pathways in general surgery (Graeber <i>et al.</i> , 2007)	Emphasize the importance of BPM for the development and implementation of pathways and evaluate its effectiveness after implementation	Development and implementation of pathways with BPM methods in a university hospital. An observational study was conducted with patients before and after the project	With the implementation of the pathways, there was a reduction in the patients' hospitalization time. Reengineering business processes via pathways reduced effort and cost and improved patient satisfaction
Information system and healthcare XXXI: Improving infection control process efficiency to reduce hospital acquired infections (Janiesch and Fischer, 2009)	Improve the efficiency of the existing control process for hospital infections	Case study in a hospital in the USA that analyzed the control process for hospital infection through "as-is" analysis and suggested possible improvements through workflow improvement (to-be design)	The implementation of a new workflow improved the quality of service and increased efficiency and patient safety. The average time before patient notification following infection was reduced from 70 to 17 hours
Application of business process management to drive the deployment of a speech recognition system in a healthcare organization (Sanchez <i>et al.</i> , 2008)	Use a methodology based on BPM to guide the development of a speech recognition system in a hospital	Development of a speech recognition system in a hospital in Spain using the Architecture of Integrated Information Systems (ARIS) methodology	The use of BPM to develop the system helped manage organizational change more efficiently. Note the satisfaction of clinical teams from the units involved in the study, which gained comprehensive knowledge regarding their units due to their involvement in modeling the processes
Absorptive capacity as a precondition for business process improvement (Manfreda <i>et al.</i> , 2014)	Analyze the role of business process modeling as a method of increasing an organization's absorptive capacity	Longitudinal case study of a public European health insurance company	There are potential problems with process modeling and design in the health insurance sector because many decisions are complex, unique, and often related to the tacit knowledge of experts
Medication errors, handoff processes and information quality: a community hospital case study (Chircu <i>et al.</i> , 2013)	Analyze how clinical handoffs contribute to or reduce medication errors	Case study in a community hospital using document analysis and interviews. The SIPOC (suppliers, inputs, processes, outputs, and customers) tool from BPM was used	The study explains how handoffs not only lead to medication errors but also help reduce them
An application of business process method to the clinical efficiency of hospital (Leu and Huang, 2011)	Understand the feasibility of implementing the BPM methodology for a health organization	Use of the ARIS business process methodology adapted for the healthcare industry. applied using a case study in the	Quality indicators showed improvement and indicate that the emergency department improved and that its effectiveness increased

Table IV.
Summary of data from the articles selected in the search for BPM and healthcare

(continued)

Article	Objective	Method	Results
Inserción de la gestión por procesos en instituciones hospitalarias: concepción metodológica y práctica (Insertion of business process management in health care organizations: methodological and practical conception) (Nariño <i>et al.</i> , 2013)	Present methodological design for process management and improvement in hospitals	emergency department of a hospital in Taiwan Analysis of 70 procedures found in the literature resulting in a procedure to use process management in hospitals and the application of this tool in a hospital in Cuba	Implementing process management according to the procedure developed and its tools helps in the development of health organizations
Improvement of hospital processes through business process management in Qaem Teaching Hospital: a work in progress (Yarmohammadian <i>et al.</i> , 2014)	Analyze BPM as a current prominent management trend for organizational change in Qaem Teaching Hospital to examine its effectiveness in the organization	Implement the BPM approach in a teaching hospital in Iran in four phases: (1) identify the current processes; (2) model/document the processes; (3) analyze and measure the processes to identify problems; and (4) finalize the documentation of the processes and improve them	The results showed significant improvements in processes. BPM enabled the organization to focus on business processes at a higher level
Developing an evaluation framework for clinical redesign programs: lessons learnt (Samaranayake <i>et al.</i> , 2016)	Present the lessons learned from the development of an evaluation framework for a clinical redesign program	Development of an evaluation framework to determine the ability of an initiative in a teaching hospital in Australia (the patient pathways program) to improve the patient journey guided by BPM and operationalized using a balanced scorecard	The use of BPM and a balanced scorecard brings clarity to the studied process and facilitates a broader approach to the development of clinical redesign programs. However, because the indicators are individual and one-dimensional, they reflect only the results of a specific process
Combining modeling and simulation approaches: How to measure performance of business processes (Bisogno <i>et al.</i>)	Provide a method for analyzing and improving the operational performance of business processes	Case study in an Italian public hospital. Analysis of the arrival process and patient treatment in an orthopedic emergency room. BPMN was used for process modeling and BPSim 1.0 was used for simulations to measure specific performance indicators (KPIs)	The method, called SimPPA, provides a virtual laboratory for testing potential process improvements. The developed method provides techniques and tools for decision makers who wish to understand and improve process performance

Source: Developed by the authors

Table IV.

occupancy rate is high, there is a problem with resource allocation. Nursing hours indicate the time spent caring for each patient, and longer hours mean a better quality of care (Leu and Huang, 2011). To conduct the study, Leu and Huang (2011) applied ARIS adapted to the health sector according to the following steps: definition of the goal – improving the

quality of medical services; value analysis to identify the activities that add value to the process; analysis of the current state of the process “as-is”; modeling what should be the case “to-be”; and computerization.

Nariño *et al.* (2013) presented a methodological design for process management and improvement in hospitals. They analyzed 70 procedures in the literature and developed a procedure for promoting BPM in hospitals. The authors applied the tool, which was developed in a hospital in Cuba, and concluded that the implementation of process management helps in the development and improvement of healthcare organizations, thereby improving the level of service offered and patient satisfaction.

Yarmohammadian *et al.* (2014) performed a project to improve processes in a teaching hospital in the Qaem Teaching Hospital in Iran. The authors selected three out of five processes indicated by a committee for process improvement. The project was performed in four phases. The first consisted of identifying the current situation and priority processes. To accomplish this task, interviews were conducted with experts and managers and, based on the concepts of the processes, workshops were conducted for pilot processes and teams were organized.

In the second phase, process modeling was performed. An overview was provided on the concepts of processes, in addition to training on modeling techniques, workshops on modeling, and the documentation of processes and development indicators. In the third phase, problems were identified through process analysis, and in the final phase, proposals for improvements were finalized and submitted to the organization. After the completion of the four stages, the improvement action plan was applied to each selected process. The results showed significant improvements in processes and enabled the organization to focus on process management.

Samaranayake *et al.* (2016) developed a framework for evaluating the ability of a clinical redesign program at a teaching hospital in Australia to improve the patient journey. The study was conducted in three steps: collection and analysis of secondary data to understand the patient discharge process using data such as “discharge time” and “delays in patient discharge”; collection and analysis of primary data through observation and interviews to understand hospital practices; and development of a framework using process mapping and modeling. They concluded that the use of BPM and a balanced scorecard to develop the framework connects strategic drivers, process improvements, targets, and measures that, when brought together, bring clarity to the patient discharge process. This facilitates a broader approach to the development of clinical redesign programs. However, due to the one-dimensional nature of individual indicators used, such as “patient discharge before 11:00 a.m.” and “clinical outcomes,” they simply reflect a result associated with a complex process.

In the study conducted by Bisogno *et al.* (2016), a method was developed for analyzing and improving the operational performance of business processes based on process modeling using BPMN and simulations using BPSim 1.0. The authors conducted a case study in the orthopaedic emergency department of an Italian public hospital. The method they developed, called SimPPA, offers techniques and tools for decision makers who want to better understand processes and improve performance; the authors stated that the method is particularly useful for highly complex or random processes such as those found in hospitals.

Results related to lean healthcare

In the search for systematic reviews that addressed lean healthcare, 272 articles were found: 112 in Scopus, 113 in PubMed, and 47 in Web of Science. Of these, 31 were excluded because they were duplicates, and 229 were excluded after the title and abstract were read and the exclusion criteria applied, which resulted in 12 articles for full analysis. These are detailed in Table V.

Title	Author	Year	Journal
A critical look at lean thinking in healthcare	Young and McClean	2008	<i>Quality and Safety in Healthcare</i>
Trends and approaches in lean healthcare	Brandão de Souza	2009	<i>Leadership in Health Services</i>
A critical review of the research literature on Six Sigma, lean and StuderGroup's Hardwiring Excellence in the USA: the need to demonstrate and communicate the effectiveness of transformation strategies in healthcare	Vest and Gamm	2009	<i>Implementation Science: IS</i>
Lean thinking in healthcare: a realist review of the literature	Mazzocato <i>et al.</i>	2010	<i>Quality and Safety in Healthcare</i>
The current state of lean implementation in healthcare: literature review	Poksinska	2010	<i>Quality Management in Healthcare</i>
Assessing the evidence of Six Sigma and lean in the health care industry	Dellifrairie <i>et al.</i>	2010	<i>Quality Management in Health Care</i>
Lean thinking in emergency departments: a critical review	Holden	2011	<i>Annals of Emergency Medicine</i>
Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare	Nicolay <i>et al.</i>	2012	<i>The British Journal of Surgery</i>
Do lean practices lead to more time at the bedside?	Brackett <i>et al.</i>	2013	<i>Journal for Healthcare Quality: Official Publication of the NAHQ</i>
Lean in healthcare: a comprehensive review	D'Andreamatteo <i>et al.</i>	2015	<i>Health Policy</i>
Lean healthcare: review, classification and analysis of literature	Costa and Godinho Filho	2016	<i>Production Planning and Control</i>
Lean interventions in healthcare: do they actually work? A systematic literature review	Moraros <i>et al.</i>	2016	<i>International Journal for Quality in Health Care</i>

Source: Developed by the authors

Table V.
Summary of data
from articles selected
in the search for "lean
healthcare"

The analysis of the articles enabled the presentation of the authors' conclusions and the articles analyzed by them, which created a greater understanding of lean healthcare and its impact on the processes in different health services.

Young and McClean (2008) visualized lean as a promising method of delivering better health services to more people using fewer resources. Given that value is the central point of lean, by means of which one seeks to eliminate waste, i.e. the steps that do not add value, the focus of the study was a proposal for a definition of what constitutes value for the end customer. It is interesting to note that the impact on the process is different based on what is considered value. In this sense, the study proposed three critical dimensions for value. The first is the clinical dimension, which is reaching the best outcome for the patient. The second is operational, which deals with the effectiveness of the service and is measured primarily in terms of cost. The third is the experience, which relates to the experience with care. The operational dimension is observed as being the dimension used as value for most implementations of lean healthcare. Finally, it is believed that the three dimensions are economically measurable, which would enable a comparative analysis of the benefits of these three dimensions.

Brandão de Souza (2009) initially highlighted that the growing increases in costs observed in the health sector do not have an equivalent improvement in quality. Lean is viewed as a way to reach these improvements because it is more adaptable to health services than other methods, such as total quality management, systems thinking, systems dynamics, the theory of constraints, reengineering, and discrete event simulation. A taxonomy of the literature related to lean healthcare in case studies and theoretical studies

was presented. In this study, the first axis studies were selected. The case studies are classified as similar to manufacturing, administrative and support, patient flow, organizational, and interorganizational. In these studies, there is a limited application of lean that is restricted to the simple use of some of the method's tools rather than the complete application (intra- and inter-organizational) of the method, as suggested by Womack and Jones (2003). In this sense, the achievement of the initial results is viewed as most important because it can motivate and engage the team for new applications (Radnor and Walley, 2008).

Vest and Gamm (2009) analyzed the effectiveness of some transformational strategies, including the use of lean healthcare. The results show improvements in a number of processes and outcomes related to health. However, despite these improvements, the articles identify methodological limitations that could undermine the validity of their results. Several articles often omitted statistical analysis, violated the assumptions of the statistical tests, and introduced selection bias; additionally, because they failed to include a comparison group, they could not exclude other external events as potential sources of nullity. Despite this bias, the authors noted that the potential for cost reduction was present in almost every article, even without specifying how much these savings would be.

Mazzocato *et al.* (2010) identified successful applications of lean thinking in different healthcare settings and classified the studies included in their review into four distinct categories that specify the different uses of lean healthcare in addition to the most appropriate tools for achieving these goals. The categories are as follows: to understand processes to identify and analyze problems; to organize processes more efficiently and/or effectively; to improve error detection, retransmit information to troubleshooters, and prevent errors that cause damage; and to manage changes and resolve problems through a scientific approach. The dynamic nature of the use of lean is shown through studies related to clinical specialties, diagnostic services, and others, such as nursing and pharmacy.

Poksinska (2010) analyzed the current state of the implementation of lean healthcare by addressing its definition, implementation process, barriers, challenges, facilitators, and the results obtained after its use. Among the author's conclusions is the perception that lean is an approach directed at processes; however, in health organizations, this type of direction remains weak. The main lean tool used is value stream mapping, which assists in reducing waiting times and repetition and ensures connection between interrelated steps. The author found that many care units operate in isolation, ignoring the effects of their work on different departments or units, which hinder the performance optimization of the entire value chain. Similarly, Mazzocato *et al.* (2010) also noted the difficulty in applying lean completely by fulfilling the five stages of implementation rather than merely using some lean tools. However, the review did not present a way to make lean a sustainable form of work rather than the simple use of some tools. The positive results originating from the application of lean thinking were classified into health system performance, employee development, and working environment.

Dellifrairie *et al.* (2010) evaluated lean with a focus on quality improvement. They noted that, in healthcare, unlike medicine and industry, evidence-based management remains an issue that needs to evolve. They found that the evidence for a relationship between the use of lean thinking and process improvements was weak. The study also showed the results obtained from the application of the methods in terms of improved clinical results, in both the care process and financial performance, highlighting the absence of a cost effectiveness assessment in the use of lean.

Holden (2011) examined the implementation of lean in 15 different emergency units in the USA, Canada, and Australia. Positive results were identified in this application, but some of the results were null or negative. Lean is characterized as an approach to process improvement accompanied by standardization through protocols. However, excess standardization can

prevent adaptation to unexpected variations, making the system more fragile. The implementation of lean creates the need for changes in the work structure to adapt to changing processes. The changes in structure detected in the study refer to data collection and monitoring, education/training, tools/technology, communication and teamwork, new roles and responsibilities for employees, the reorganization of physical space, and others. The changes in processes already include new operational processes and the procedures related to them. Thus, these changes indirectly affect patients and directly and indirectly affect the employees of the health service. The employee-patient relationship can also be altered by these changes in a positive, zero-sum, or negative fashion. Finally, it appears that the successful deployment of lean depends on how this method is adapted to a given context.

Nicolay *et al.* (2012) examined the application of quality improvement methods from the manufacturing industry to surgical healthcare. It was found that the improvement of methodologies from industry, including lean, has been successfully applied in different aspects of healthcare, particularly in repetitive processes that can be standardized. However, limitations of evidence have been observed regarding the use of lean because localized studies showed no data concerning the time period before application, which makes the verification of the improvements imprecise.

Brackett *et al.* (2013) examined whether the use of lean could increase the time spent by nurses in contact with patients. Positive but minimal results were found in all of the articles studied. Similarly, in Nicolay *et al.* (2012), methodological flaws that reduce the quality of the studies were found. There is a lack of evidence providing support for these improvements, which does not make it possible to conclude whether lean substantially influences patient care or increases the time spent by nurses at the patient's bedside. Among this lack of evidence is the lack of statistical analysis and controls to ensure the effectiveness of the intervention, which means that, therefore, the results are not based on empirical data. The study concluded that it is not possible to connect greater time spent by the patient's side with the use of lean.

In their comprehensive review of lean healthcare, D'Andreanmatteo *et al.* (2015) identified the more widespread use of this methodology in different health services and in regard to a broader organizational reach.

Costa and Godinho Filho (2016) proposed an update of the literature reviews of Mazzocato *et al.* (2010) and Brandão de Souza (2009) and the classification and analysis of the literature. Like Mazzocato *et al.* (2010), the authors found studies in which lean thinking was deployed in only one process, unit, or specific department, which also occurred in the industry. However, they highlighted the existence of system-wide lean applications, for example, in hospital that sought to improve patient flow through the emergency department; this goal was broadened to include redesigning the clinical and surgical patient handling and improvements in key support services. The deployment of lean thinking expanded after the first project was successful and positive results were obtained. The use of lean thinking has also expanded in terms of the number of countries using it, with publications referring to its use in the Netherlands and Brazil being found. Regarding classification of the literature, the authors allocated lean applications into five categories: the first includes support activities such as an information department; the second includes areas similar to manufacturing operations due to their repetitive nature, such as laboratories and pharmacies; the third includes clinical and therapeutic operations, such as those found in emergency departments; the fourth category includes hospitals, where lean applications are included in the hospital as a whole; and finally, the fifth category includes lean applications in unspecified locations. The benefits of using lean thinking highlighted by the authors are decreases in waiting time, cost, and length of stay and an increase in capacity.

In addition to performing a literature review, Moraros *et al.* (2016) presented the experience of the Canadian province of Saskatchewan in more detail. They considered this

representative of the greatest transformation afforded by the use of lean healthcare. Lean thinking was applied to different hospitals in the province, and the results were evaluated using pre- and post-lean surveys of tens of thousands of patients who used the province's hospitals. The survey was distributed from December 2009 to March 2014, and the deployment of lean thinking began in February 2012. In addition to patients, the study included interviews with 1,500 nurses who had direct experience with lean thinking. The study identified 30 different results of the lean deployment, of which only three were statistically significant in the pre- and post-lean comparison (staff washing or disinfecting their hands, staff checking ID bands, and patients being given safety brochures). The interviews with nurses revealed that all 15 results obtained with lean thinking showed statistically significant negative effects of lean thinking on nurse engagement, usefulness, patient care, time for patient care, workplace issues, availability of supplies, workload, stress, and patient safety. Before the results obtained from this application of lean thinking are presented, it is important to note that no statistical significance with respect to patient satisfaction and outcomes relating to health improvements was obtained. Furthermore, a negative association was established between financial costs and employee satisfaction. The positive results detected in the 22 studies included in the review included a reduced relative rate of methicillin-resistant staphylococcus aureus infection, a reduction in patient visits, a reduction in surgical consults, and improved time-dependent stroke care. Other positive results included patients leaving without being seen, patients being discharged within 48 hours, and a reduction in the number of patients readmitted to the hospital within 72 hours. These results were not statistically significant.

Therefore, despite the belief that lean thinking generates improvements in healthcare quality, no evidence supporting this claim was found. Moreover, improvements in processes and health are affected by a variety of internal and external variables; therefore, the impact of a specific methodology, such as lean thinking, on such improvements is potentially minimal (Moraros *et al.*, 2016).

Discussion

Process standardization has a significant impact on process performance in general and on process time, cost, and quality in particular (Münstermann *et al.*, 2010); as observed in the study by Yarmohammadian *et al.* (2014), the negative effects of the high complexity of the health sector, in addition to the high dynamism of the sector's processes, are ameliorated by the change in management to focus on processes and their consequent improvement. The results of this study support the assertion by Neubauer (2009) that the promotion of BPM enables a quick adaptation to change because, according to the study, the perceived negative effects of the sector's high dynamism are mitigated.

Chircu *et al.* (2013) claimed that activities in a BPM design must be classified as activities that add or do not add value to eliminate the latter group and increase efficiency. However, in the study by Manfreda *et al.* (2014), it can be observed that the greatest obstacle encountered in promoting BPM is the difficulty in eliminating these activities because the study involves a public sector organization. The authors stated that the legal characteristics (job stability, the need for legislative authorization, etc.) make it difficult to eliminate activities and reallocate people, even if their current activities do not add value. Thus, it can be observed that the theory related to the principles related to promoting BPM in companies should be analyzed with caution because there may be specific features of certain organizations or sectors that prevent some activities from being eliminated or modified due to specific regulations.

Handoffs should be minimized to avoid making the process more vulnerable (Spanyi, 2010). However, Chircu *et al.* (2013) stated that a process with many handoffs can help reduce errors because the information passes through a greater number of people, increasing the probability

of error detection. At the same time, it should be noted that, if the activities are performed properly from the beginning of the process, a large number of handoffs is not necessary to detect possible errors.

Table VI presents a comparison matrix of the gains reported in the selected studies. The gains were classified into 11 broader categories: mortality, costs, time, errors, profit, customer satisfaction, employee satisfaction, productivity, service level, patient safety, and “did not measure gains.” The category “did not measure gains” included the studies whose objectives did not include the measurement of the gains resulting from the promotion of BPM or lean healthcare. It is important to stress that the number of studies analyzed in this systematic review of lean healthcare is significantly higher, and therefore, the amount gained is much more expressive. Furthermore, as stated by Moraros *et al.* (2016), improvements in processes and health are affected by a variety of internal and external variables.

As shown in Table VI, only the studies by Graeber *et al.* (2007) and Leu and Huang (2011) showed cost savings resulting from the promotion of BPM, whereas eight studies suggested that lean healthcare led to cost reductions: Brandão de Souza (2009), Vest and Gamm (2009), Mazzocato *et al.* (2010), Poksinska (2010), Dellifraime *et al.* (2010), D'Andreamatteo *et al.* (2015), Costa and Godinho Filho (2016), and Moraros *et al.* (2016). Only the study by Chircu *et al.* (2013) showed a reduction in errors resulting from the promotion of BPM, whereas such a reduction was reported for lean healthcare in the studies by Brandão de Souza (2009), Mazzocato *et al.* (2010), Poksinska (2010), and Dellifraime *et al.* (2010). Gains in the level of service were reported for BPM by Janiesch and Fischer (2009), Leu and Huang (2011), Nariño *et al.* (2013), Brandão de Souza (2009), and Mazzocato *et al.* (2010).

The most noteworthy gains associated with lean healthcare were in the productivity/efficiency category; nearly all the studies found gains. The category profit is also notable in that only two studies (Young and McClean, 2008; Brandão de Souza, 2009) showed a gain in profit, although numerous studies identified cost reductions (Brandão de Souza, 2009; Vest and Gamm, 2009; Dellifraime *et al.*, 2010; Mazzocato *et al.*, 2010; Poksinska, 2010; D'Andreamatteo *et al.*, 2015; Costa and Godinho Filho, 2016; Moraros *et al.*, 2016). None of the studies related to BPM demonstrated decreased mortality or higher profit. Both approaches showed gains in some aspects of each of the remaining categories.

Regarding the promotion of BPM, in the ten selected articles, the following could be observed:

- (1) cost reduction (two papers);
- (2) time reduction (three papers);
- (3) error reduction (one paper);
- (4) increased patient satisfaction (two papers);
- (5) increased employee satisfaction (one paper);
- (6) increased productivity (two papers);
- (7) increased service level (three papers); and
- (8) increased patient safety (one study).

Regarding the results of lean healthcare studies, in the 12 studies, the following could be observed:

- (1) mortality reduction (1 paper);
- (2) cost reduction (8 papers);
- (3) time reduction (9 papers);

Table VI.
Comparison matrix

Article	Decrease				Gains				Did not measure		
	Mortality	Cost	Time	Error	Profit	Customer satisfaction	Employee satisfaction	Increase Productivity/efficiency		Service level	Patient safety
<i>BPM</i>											
Graeber <i>et al.</i> (2007)		X	X			X					
Janiesch and Fischer (2009)		X	X				X	X	X	X	
Sanchez <i>et al.</i> (2008)											X
Manfreda <i>et al.</i> (2014)											
Chircu <i>et al.</i> (2013)				X							
Leu and Huang (2011)		X	X					X	X		
Nariño <i>et al.</i> (2013)						X			X		
Yamohammadian <i>et al.</i> (2014)								X			
Samarayake <i>et al.</i> (2016)											X
Bisogno <i>et al.</i> (2016)											X
<i>Lean thinking</i>											
Young and McClean (2008)			X		X			X		X	
Brandão de Souza (2009)			X	X	X	X	X	X	X	X	
Vest and Gamm (2009)		X							X		
Mazzocato <i>et al.</i> (2010)		X	X	X		X	X	X	X		
Pokinska (2010)	X	X	X	X		X	X	X			
Dellifraine <i>et al.</i> (2010)		X	X	X		X		X			
Holden (2011)			X				X	X			
Nicolay <i>et al.</i> (2012)			X			X	X	X		X	
Brackett <i>et al.</i> (2013)						X	X	X		X	
D'Andreomatteo <i>et al.</i> (2015)		X					X	X		X	
Costa and Godinho Filho (2016)		X	X					X			
Moraros <i>et al.</i> (2016)		X	X					X			X

- (4) error reduction (4 papers);
- (5) profit increase (2 papers);
- (6) increased patient satisfaction (6 papers);
- (7) increased employee satisfaction (6 papers);
- (8) increased productivity (11 papers);
- (9) increased service level (2 papers); and
- (10) increased patient safety (8 studies).

BPM is a management approach focused on the client (Hammer, 2010). The transformation of processes seeks to meet the expectations of these processes and improve the quality of products and services (Burlton, 2010; Trkman *et al.*, 2015), which can be observed in the studies by Leu and Huang (2011) and Nariño *et al.* (2013). The former identifies an improvement in the quality of medical services offered to patients and the effectiveness of the organization after promoting BPM; the latter identifies an improvement in the quality of services provided and patient satisfaction.

With regard to the study by Leu and Huang (2011), in the phase of the study with the analysis of the processes' value, the processes that add value (diagnosis) and those that do not add value (waiting, for example) were identified, as suggested by Chircu *et al.* (2013), who attempt to focus on processes that add value. In the phase of this study that consisted of the analysis of the process "as-is," problems related to the physical layout, the lack of standardization of clinical processes, and the lack of allocation of resources to processes generating bottlenecks and gaps in information systems were identified.

With respect to lean healthcare, Nicolay *et al.* (2012) showed that, despite the good performance of the application of this methodology in different aspects of the health service, the results are better when its use occurs in repetitive processes that can be standardized. The studies found in the review show that the use of lean healthcare presents positive results, regardless of the tools used or the location of its application.

In contrast to these positive results, Andersen *et al.* (2014) showed that there is conflicting evidence in the results of lean healthcare, with qualitative and quantitative studies frequently contradicting each other. Dellifraigne *et al.* (2010) and Moraros *et al.* (2016) showed that one cannot claim that the results of using lean healthcare are as good as those reported due to problems with methodology or evidence. Brackett *et al.* (2013) claimed that many academics in the area of management have said that lean healthcare application to health is a fad and suggested that the evidence for improvement is very weak. Young and McClean (2008) stated that it is more a matter of belief than evidence that lean can improve as significant a sector as the health sector. Vest and Gamm (2009) agreed, stating that among the studies analyzed in their review, the majority omitted statistical analysis or violated assumptions of statistical tests, introduced selection bias and failed to include a comparison group, so it was not possible to exclude other external events as potential sources of nullity.

It was found that the use of lean in healthcare is limited. Even if all applications of lean healthcare show positive results, whereas the theory emphasizes the holistic view, most of the articles studied present a targeted technical application with limited organizational reach (Mazzocato *et al.*, 2010; Costa and Godinho Filho, 2016). This corroborates the claim that the use of this approach does not imply that the organization is committed to BPM (ABPMP, 2013). Despite this finding, Costa and Godinho Filho (2016) highlighted some holistic (intra-organizational) applications of this methodology in health services, which may demonstrate its maturity. Another important advance offered by lean thinking and highlighted by Brandão de Souza (2009) is its inter-organizational integration with companies in the same supply chain. Regarding the studies that addressed BPM, of the ten

articles selected, one study showed challenges in promoting management that focused on processes, in which decisions were unique and difficult to model, and four were conducted in different sectors of hospitals and attempted to promote BPM to improve processes and increase the efficiency and effectiveness of the services offered by these institutions. Other findings of these studies included the following:

- (1) reduced in hospital stays (Graeber *et al.*, 2007);
- (2) increased efficiency and efficacy (Leu and Huang, 2011);
- (3) quicker patient notification after infection (Janiesch and Fischer, 2009);
- (4) help with organizational change (Sanchez *et al.*, 2008);
- (5) understanding the end-to-end process (Sanchez *et al.*, 2008);
- (6) understanding the importance of some handoffs for patient safety (Chircu *et al.*, 2013); and
- (7) improvement in the organization's focus on high-level processes (Yarmohammadian *et al.*, 2014).

Costa and Godinho Filho (2016) and Mazzocato *et al.* (2010) stressed that despite the fact that few articles identify the application of lean thinking in an integrated manner across the organization, when this process was based on an action plan that focused on improving the entire company's performance, it apparently began to operate in a more process-oriented manner, which reduced costs and increased quality. There is still a gap between partial application and system-wide application.

In the BPM approach, lean thinking is seen as one of the different knowledge sets, applicable primarily to the transformation of processes aimed at reducing waste. In this sense, although the two approaches have been treated separately throughout this paper, BPM encompasses lean healthcare and its benefits, whereas the converse is not true when only lean healthcare is implemented. As a result, when this methodology is applied in health organizations, it is usually applied only partially, limited to a few processes and sectors. Lean healthcare is more widely applied in the health sector and can act as a point of entry for applying BPM. This approach could increase the benefit to final users by filling the gaps left by the use of lean healthcare alone.

Conclusions and research agenda

The present study allowed us to achieve our proposed objective of analyzing studies on BPM and lean thinking as approaches to healthcare process management. The studies found showed the importance of promoting BPM in the health sector to improve the quality of the services offered to patients.

With regard to lean, there is a wide dissemination of this method in the healthcare industry. The results found after the application of lean were positive, regardless of the application site. However, its implementation was focused, ignoring the relationship or influence of inter- and intra-organizational processes. Moreover, methodological weaknesses were highlighted in the studies that used lean healthcare, which can negatively influence the results. Thus, applications were sporadic with specific goals, often ignoring the holistic view addressed in BPM. Unlike what occurs with lean, promoting BPM remains little explored in the healthcare industry. Few studies have actually evaluated this approach in practice. However, it is noted that there is an interest in this subject among several areas, given that the articles found were published in journals from different areas.

Among the articles on lean healthcare found in the reviews, other approaches to improving processes and quality were emphasized, but BPM was not noted. It was possible

to observe that the promotion of BPM can help healthcare organizations formalize the steps of service provision and act on specific points to improve service, the waiting time, the environment, and the workflow of various health professionals. In addition, the progress of the process can be monitored, allowing the retrieval of important information that can contribute to epidemiological studies and improve human health by improving the process of care and service.

To contribute to the development of future studies related to this subject, the following research agenda, with topics considered relevant based on the presented theory, was developed:

- Conduct studies that focus on the orchestration of processes and the control of the flow of information within healthcare organizations because some of the studies presented showed that the quality of information transmitted from a professional or sector influences the quality of the process, i.e. the service offered to the patient.
- Compare the costs to an organization before and after promoting BPM to assess whether there is a reduction in costs after orienting the process and whether this reduction is significant.
- Study the patient journey in order to minimize waiting time and hospitalization, increase patient satisfaction and lower mortality rates.
- Identify whether and how cost reductions are related to higher profits.
- Better identify and understand the most common handoffs that occur in hospitals to identify opportunities for improvement that can be applied in other similar institutions, focusing mainly on error reduction.
- Analyze whether the spread of the use of lean healthcare in healthcare organizations facilitates the implementation of BPM.
- Analyze the processes that extend beyond the limits of the organization, such as radiodiagnostic services, to identify ways to integrate these organizations and processes.
- Perform empirical studies that employ lean tools to achieve specific goals while simultaneously promoting BPM in the organization, thus taking a holistic view of the processes.

The results of this study may help other researchers in identifying research gaps in the promotion of BPM and lean in the health sector and in developing relevant research. In addition, by understanding how health organizations are promoting management focused on processes and the results obtained with this approach, managers from other organizations, especially in this sector, can reflect and develop similar actions to improve the quality of services offered, increase productivity and client satisfaction, and reduce costs, errors, and waiting time.

The limitations of this study include the fact that there may be studies that address the promotion of BPM in the health sector but that could not be found because they use other types of nomenclature or theories to refer to the same subject. Another limitation is the failure to include professional studies because these were inaccessible internal data belonging to organizations and thus not included in academic databases.

References

- Al-Araidah, O., Momani, A., Khasawneh, M. and Momani, M. (2010), "Lead-time reduction utilizing lean tools applied to healthcare: the inpatient pharmacy at a local hospital", *Journal for Healthcare Quality*, Vol. 32 No. 1, pp. 59-66.
- Andersen, H., Røvik, K.A. and Ingebrigtsen, T. (2014), "Lean thinking in hospitals: is there a cure for the absence of evidence? A systematic review of reviews", *BMJ Open*, Vol. 4 No. 1, pp. 1-8.

- Association of Business Process Management Professionals (ABPMP) – Brasil (2013), *Guide to the Business Process Management Common Body of Knowledge (BPM CBOK)*, V.3.0, ABPMP, Springfield, IL.
- Becker, J., Fischer, R. and Janiesch, C. (2007), "Optimizing US health care processes: a case study in business process management", *Proceedings of the Thirteenth Americas Conference on Information Systems, Keystone, CO, August 10-12*.
- Bisogno, S., Calabrese, A., Gastaldi, M. and Ghiron, N.L. (2016), "Combining modelling and simulation approaches", *Business Process Management Journal*, Vol. 22 No. 1, pp. 56-74.
- Bitkowska, A. (2015), "The orientation of business process management toward the creation of knowledge in enterprises", *Human Factors and Ergonomics in Manufacturing & Service Industries*, Vol. 25 No. 1, pp. 43-57.
- Brackett, T., Comer, L. and Whichello, R. (2013), "Do lean practices lead to more time at the bedside?", *Journal for Healthcare Quality*, Vol. 35 No. 2, pp. 7-14.
- Brandão de Souza, L. (2009), "Trends and approaches in lean healthcare", *Leadership in Health Services*, Vol. 22 No. 2, pp. 121-139.
- Burlton, R. (2010), "Delivering business strategy through process management", in Brocke, J.V. and Rosemann, M. (Eds), *Handbook on Business Process Management 2: Strategic Alignment, Governance, People and Culture*, Springer Verlag, Berlin, pp. 45-78.
- Cannavacciuolo, L., Illario, M., Ippolito, A. and Ponsiglione, C. (2015), "An activity-based costing approach for detecting inefficiencies of healthcare processes", *Business Process Management Journal*, Vol. 21 No. 1, pp. 55-79.
- Chircu, A.M., Gogan, J.L., Boss, S.R. and Baxter, R. (2013), "Medication errors, handoff processes and information quality: a community hospital case study", *Business Process Management Journal*, Vol. 19 No. 2, pp. 201-216.
- Cohen, M.D. and Hilligoss, P.B. (2010), "The published literature on handoffs in hospitals: deficiencies identified in an extensive review", *Quality and Safety in Health Care*, Vol. 19 No. 6, pp. 493-497.
- Costa, L.B.M. and Godinho Filho, M. (2016), "Lean healthcare: review, classification and analysis of literature", *Production Planning and Control*, Vol. 27 No. 10, pp. 823-836.
- D'Andreamatteo, A., Ianni, L., Lega, F. and Sargiacomo, M. (2015), "Lean in healthcare: a comprehensive review", *Health Policy*, Vol. 119 No. 9, pp. 1197-1209.
- Dellifraire, J.L., Langabeer, J.R. and Nembhard, I.M. (2010), "Assessing the evidence of six sigma and lean in the health care industry", *Quality Management in Health Care*, Vol. 19 No. 3, pp. 211-225.
- Ginter, P.M., Duncan, W.J. and Swayne, L.E. (2013), *Strategic Management of Health Care Organizations*, John Wiley & Sons, San Francisco, CA.
- Gonçalves, P.D., Hagenbeek, M.L. and Vissers, J.M. (2013), "Hospital process orientation from an operations management perspective: development of a measurement tool and practical testing in three ophthalmic practices", *BMC Health Services Research*, Vol. 13 No. 1, pp. 1-14.
- Graeber, S., Richter, S., Folz, J., Pham, P.T., Jacob, P. and Schilling, M.K. (2007), "Clinical pathways in general surgery: development, implementation, and evaluation", *Methods of Information in Medicine*, Vol. 46 No. 5, pp. 574-579.
- Hammer, M. (2010), "What is business process management?", in Brocke, J.V. and Rosemann, M. (Eds), *Handbook on Business Process Management 1: Introduction, Methods and Information Systems*, Springer Verlag, Berlin, pp. 3-16.
- Hochrein, S., Glock, C.H., Bogaschewsky, R. and Heider, M. (2015), "Literature reviews in supply chain management: a tertiary study", *Management Review Quarterly*, Vol. 65 No. 4, pp. 239-280.
- Holden, R.J. (2011), "Lean thinking in emergency departments: a critical review", *Annals of Emergency Medicine*, Vol. 57 No. 3, pp. 265-278.
- Janiesch, C. and Fischer, R. (2009), "Information system and healthcare XXXI: improving infection control process efficiency to reduce hospital acquired infections", *Communications of the Association for Information System*, Vol. 24 No. 33, pp. 558-570.

- Kirchmer, M., Laengle, S. and Masias, V. (2013), "Transparency-driven business process management in healthcare settings", *IEEE Technology and Society Magazine*, Vol. 32 No. 4, pp. 14-16.
- Kitchenham, B.A. (2007), "Guidelines for performing systematic literature reviews in software engineering", EBSE Technical Report No. EBSE-2007-01, Software Engineering Group School of Computer Science and Mathematics, Lund, September 22, 2012.
- Laursen, M.L., Gertsen, F. and Johansen, J. (2003), "Applying lean thinking in hospitals – exploring implementation difficulties", *3rd International Conference on the Management of Healthcare and Medical Technology*, May 19, 2010, available at: www.lindgaardconsulting.dk/pdf/altih.pdf
- Lenz, R. and Reichert, M. (2007), "IT support for healthcare processes – premises, challenges, perspectives", *Data & Knowledge Engineering*, Vol. 61 No. 1, pp. 39-58.
- Leu, J. and Huang, Y. (2011), "An application of business process method to the clinical efficiency of hospital", *Journal of Medical Systems*, Vol. 35 No. 3, pp. 409-421.
- Maddern, H., Smart, P.A., Maull, R.S. and Childe, S. (2013), "End-to-end process management: implications for theory and practice", *Production Planning & Control*, Vol. 25 No. 16, pp. 1303-1321.
- Manfreda, A., Kovacic, A., Štemberger, M.I. and Trkman, P. (2014), "Absorptive capacity as a precondition for business process improvement", *Journal of Computer Information Systems*, Vol. 54 No. 2, pp. 35-43.
- Mazzocato, P., Savage, C., Brommels, M., Aronsson, H. and Thor, J. (2010), "Lean thinking in healthcare: a realist review of the literature", *Quality & Safety in Health Care*, Vol. 19 No. 5, pp. 376-382.
- Moraros, J., Lemstra, M. and Nwankwo, C. (2016), "Lean interventions in healthcare: do they actually work? A systematic literature review", *International Journal for Quality in Health Care*, Vol. 28 No. 2, pp. 150-165.
- Münstermann, B., Eckhardt, A. and Weitzel, T. (2010), "The performance impact of business process standardization: an empirical evaluation of the recruitment process", *Business Process Management Journal*, Vol. 16 No. 1, pp. 29-56.
- Nariño, H., Rivera, D.N., León, A.M. and León, M.M. (2013), "Inserción de la gestión por procesos en instituciones hospitalarias: concepción metodológica y práctica", *Revista de Administração, São Paulo*, Vol. 48 No. 4, pp. 739-756.
- Neubauer, T. (2009), "An empirical study about the status of business process management", *Business Process Management Journal*, Vol. 15 No. 2, pp. 166-183.
- Nicolay, C.R., Purkayastha, S., Greenhalgh, A., Benn, J., Chaturvedi, S., Phillips, N. and Darzi, A. (2012), "Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare", *The British Journal of Surgery*, Vol. 99 No. 3, pp. 324-335.
- Niehaves, B., Poepplbuss, J., Plattfaut, R. and Becker, J. (2014), "BPM capability development – a matter of contingencies", *Business Process Management Journal*, Vol. 20 No. 1, pp. 90-106.
- Ohno, T. (1988), *Toyota Production System: Beyond Large-Scale Production*, Productivity Press, Portland, OR.
- Paim, R., Caulliraux, H.M. and Cardoso, R. (2008), "Process management tasks: a conceptual and practical view", *Business Process Management Journal*, Vol. 14 No. 5, pp. 694-723.
- Poksinska, B. (2010), "The current state of lean implementation in health care: literature review", *Quality Management in Health Care*, Vol. 19 No. 4, pp. 319-329.
- Radnor, Z. and Walley, P. (2008), "Learning to walk before we try to run: adapting lean for the public sector", *Public Money & Management*, Vol. 28 No. 1, pp. 13-20.
- Rebuge, Á. and Ferreira, D.R. (2012), "Business process analysis in healthcare environments: a methodology based on process mining", *Information Systems*, Vol. 37 No. 2, pp. 99-116.
- Reijers, H.A. (2006), "Implementing BPM systems: the role of process orientation", *Business Process Management Journal*, Vol. 12 No. 4, pp. 389-409.

- Samaranayake, P., Dadich, A., Fitzgerald, A. and Zeitz, K. (2016), "Developing an evaluation framework for clinical redesign programs: lessons learnt", *Journal of Health Organization and Management*, Vol. 30 No. 6, pp. 950-970.
- Sanchez, M.J.G., Framiñán Torres, J.M., Parra Calderón, C.L., Del Rio Ortega, J.A., Vigil Martin, E. and Nieto Cervera, J. (2008), "Application of business process management to drive the deployment of a speech recognition system in a healthcare organization", *Studies in Health Technology and Informatics*, Vol. 16 No. 136, pp. 511-516.
- Spanyi, A. (2010), "Business process management governance", in Brocke, J.V. and Rosemann, M. (Eds), *Handbook on Business Process Management 2: Strategic Alignment, Governance, People and Culture*, Springer Verlag, Berlin, pp. 223-238.
- Sturmberg, J.P. and Martin, C.M. (Eds) (2013), *Handbook of Systems and Complexity in Health*, Springer Science & Business Media, New York, NY.
- Trkman, P. (2010), "The critical success factors of business process management", *International Journal of Information Management*, Vol. 30 No. 2, pp. 125-134.
- Trkman, P., Mertens, W., Viaene, S. and Gemmel, P. (2015), "From business process management to customer process management", *Business Process Management Journal*, Vol. 21 No. 2, pp. 250-266.
- Verma, N. (2009), *Business Process Management: Profiting from Process*, Global India Publications, New Delhi.
- Vest, J.R. and Gamm, L.D. (2009), "A critical review of the research literature on Six sigma, lean and StuderGroup's hardwiring excellence in the United States: the need to demonstrate and communicate the effectiveness of transformation strategies in healthcare", *Implementation Science*, Vol. 4 No. 1, pp. 1-9.
- vom Brocke, J.M., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R. and Cleven, A. (2009), "Reconstructing the giant: on the importance of rigour in documenting the literature search process", *17th European Conference on Information Systems, Verona*, pp. 1-13.
- Webster, J. and Watson, R.T. (2002), "Analyzing the past to prepare for the future: writing a literature review", *MIS Quarterly*, Vol. 26 No. 2, pp. 13-23.
- Womack, J. and Jones, D.T. (2003), *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, 2nd ed., Free Press, New York, NY.
- Womack, J., Jones, D.T. and Roos, D. (2007), *The Machine That Changed the World*, Free Press, New York, NY.
- Yarmohammadian, M.H., Ebrahimipour, H. and Doosty, F. (2014), "Improvement of hospital processes through business process management in Qaem Teaching Hospital: a work in progress", *Journal of Education and Health Promotion*, Vol. 3, pp. 1-5.
- Young, T.P. and McClean, S.I. (2008), "A critical look at lean thinking in healthcare", *Quality & Safety in Health Care*, Vol. 17 No. 5, pp. 382-386.

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