Benefits and Limitations of Business Process Model Notation in Modeling Patient Healthcare Trajectory: A Scoping Review Protocol

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Systematic Review

Keywords: Healthcare trajectory, healthcare management, business process modelling notation, healthcare processes, care pathways, scoping review

Posted Date: December 9th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-1153488/v1>

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Abstract

Introduction:

The adoption of business process model notation (BPMN) in modeling healthcare trajectory can enhance the efficiency and efficacy of healthcare organizations and ultimately improve patient outcomes while restraining costs. However, existing systematic reviews have been inconclusive regarding the effectiveness of BPMN in modeling healthcare trajectory. The aims of this scoping review are to map and aggregate existing evidence on the main benefits and limitations associated with BPMN in healthcare trajectory and highlight areas of improvement on using BPMN and its extensions in healthcare practices, which have not been systematically scoped.

Methods and Analysis

: The proposed scoping review will be performed in accordance with the methodological framework suggested by Arksey and O'Malley and further refined by Levac et al. A wide range of electronic databases and grey literature sources will be systematically searched using predefined keywords, from 2004 onwards. The review will include any study design with a focus on the application of the BPMN approach applied for optimizing healthcare trajectories (e.g., diagnostic, and therapeutic process, decision making, cost, and resources), published in either English or French. Two reviewers will independently screen titles, abstracts, and full-text articles and select studies meeting the inclusion criteria. A customized data extraction form will be used to extract data from the included studies. The results will be presented in tabular format developed iteratively by the research team.

Ethics and dissemination

: Research ethics approval is not required as exclusively secondary data will be used. Review findings will be used to advance understanding about BPMN, its extensions and its application in healthcare trajectory optimization. The review will develop recommendations about how to tailor BPMN strategies at optimizing care pathways and decision-making processes. Our findings will be disseminated in peer-reviewed journals and presentations and through discussions with relevant organizations and stakeholders.

Strengths And Limitations Of This Study

- This scoping review will provide a deeper understanding of how BPMN interventions improve organisational practices, clinical practices, and patient outcomes in healthcare organisations.
- The study will provide a synthesis of the existing evidence about how to implement BPMN consistently and effectively in care processes.

- Findings from this review will be used to elaborate recommendations about how to tailor BPMN interventions in healthcare trajectory optimization.
- The quality appraisal of publications captured will not be assessed, as it is beyond the aim of a scoping review.
- The inclusion criteria include both peer-reviewed and grey literature to ensure comprehensiveness but will be limited to publications in French and English.

Introduction

With the continuous challenges facing healthcare organizations in the past few years¹⁻³, many interventions have focused on process improvements with the objective of enhancing efficiency and efficacy to improve patient outcomes while controlling costs^{4,5}. Through the years, health expenditure and financing has increased substantially in developed countries such as the United States (US) and Canada⁶⁻⁹. In 2019, Canada spent 10.8% of its gross domestic product on healthcare expenses according to the Organization for Economic Cooperation and Development (OECD)⁹. This ratio reached 17.7% in the US and by 2028, their national health spending is projected to reach \$6.2 trillion, growing at an average annual rate of 5.4%^{8,9}.

Nevertheless, the quality of care and patient safety cannot be neglected and remain a major concern leading to higher costs of healthcare delivery¹⁰⁻¹². Since the released Crossing the Quality Chasm^{13,14} by the Institute of Medicine (US), numerous national and international organizations including the Academies of Sciences¹⁵ and the World Health Organization^{16,17} have repeated calls to develop a framework for advancing the quality of care, ensuring that care is safe, effective, efficient, patient centered, timely, and equitable¹³. To do this, healthcare organizations and systems must develop solutions that enhance both efficiency and efficacy of improving healthcare organization and patient outcomes while restraining costs. Work on improving clinical and care pathways has shown such benefits¹⁸⁻²⁰. Over the last decades, studies have revealed that mapping healthcare trajectories allowed to decrease the variation of professional practices and to standardize care processes¹⁰⁻¹². This practice has many benefits such as improving accessibility, fluidity, quality and performance of healthcare services, and sustainability^{18,21}.

In this context, several tools have been developed to support process improvement through process mapping. Among these methods, business process modeling notation (BPMN) is an approach that consists of representing processes as a network of activities and tasks²²⁻²⁴. This structured approach supported by the Object Management Group since 2005 and adopted as an international standard by the International Organization for Standardization since 2012, is in its second version (BPMN 2.0)²³⁻²⁵. In recent years, a few reviews have been conducted to analyze whether BPMN approach can become a useful tool to improve the effectiveness and quality of healthcare processes. For instance, Loya et al.²⁶ used a service-oriented architecture in clinical decision support and provided evidence that BPMN was

not commonly used for clinical decision support systems, despite being the preferred standard for business process modeling in healthcare. Mincarone et al.²⁷ demonstrated that BPMN provides a good level of formalization, a standardized communication framework between multiple stakeholders, good user comprehensibility, and facilitates interprofessional analysis. However, those authors^{26,27} also highlighted limitations such as the need for appropriate training, the lack of consideration for early detection and correction of errors in the process and finally the resources required that outweigh the overall benefits. In addition, Fernández et al.²⁸ suggested that BPMN is useful for standardizing processes that have some variability due to its possibility to incorporate variations or changes. Moreover, Zarour et al.²⁹ analyzed various BPMN extensions (e.g., decision modelling notation) that can be used to improve its efficiency in many domains, showing that healthcare was among the most targeted area. The overall conclusion of these reviews²⁶⁻²⁹ is that BPMN seems to be increasingly used in healthcare organizations to the point of becoming a standard in process improvement methods. However, the existing reviews²⁶⁻²⁹ have found it difficult to draw conclusions about the effectiveness of BPMN in modeling healthcare trajectory. Our literature review will go much further by providing an in-depth analysis of the ability of BPMN to effectively improve the quality of clinical practices, the security, and the fluidity of the care process and to propose tangible results on the patient experience in a patient-centered care and services logic. Moreover, we will analyze the opportunities and limitations in integrating the potential of BPMN extensions.

Considering the above gaps in the literature, the aims of this scoping review are to identify and map existing evidence on the main benefits and limitations associated with BPMN in healthcare trajectory, by determining its ability to model the various key dimensions or concepts of a healthcare process and its ability to meet the needs of healthcare stakeholders. The review will also highlight the capacity of BPMN approach and its extensions to support clinical activities and decision-making processes in healthcare trajectory and will establish a conceptual framework for improving the use of BPMN in healthcare practices.

Methods And Analysis

We chose to undertake a scoping review as the best method to map the available evidence regarding the benefits and limitations of BPMN in modeling patient healthcare trajectory³⁰⁻³². The present review will be conducted following the methodological frameworks described by Arksey and O'Malley³⁰, and improved by Levac et al.³¹, and further refined by the Joanna Briggs Institute (JBI)³³. The standardized methodology included six-stages for scoping review: (1) Identifying the research question, (2) Identifying relevant studies and grey literature, (3) Selecting studies, (4) Charting the data, (5) Collating, summarizing, and reporting the data, and (6) Consulting with relevant stakeholders, thereby enabling knowledge translation. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR)^{32,34} has also been used to guide the reporting of this protocol and will also subsequently be used to structure the reporting of the full review. Furthermore, we will take an iterative and reflexive approach throughout the review process, particularly to refine our study

selection and data extraction steps to best target meeting our objective. This protocol is registered through the Open Science Framework.

Stage 1: Identifying the research question

As the focus of scoping reviews is on summarizing the breadth of evidence, the research questions should be broad while keeping in mind the review's main purpose^{30,31,33,34}. Thus, we started with, "What is known about the application of BPMN methodology in healthcare organization?" A preliminary search on our research question was conducted through some electronic databases including International Prospective Register of Systematic Reviews, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and National Center for Biotechnology Information, revealed three systematic reviews of modeling healthcare processes using the BPMN methodology^{27,28}. Although findings from these reviews²⁶⁻²⁹ supported the use of BPMN as an effective methodology to optimize healthcare processes, these studies²⁶⁻²⁹ highlighted that they came across substantial variabilities in how they reviewed studies. Indeed, a limitation of these studies²⁶⁻²⁹ is that none of them put the use of BPMN to improve healthcare trajectories or patient care trajectory as its primary focus. Loya et al.²⁶ focused on the use of BPMN for supporting clinical decisions and stated that BPMN has potential to optimize clinical pathways, but they did not assess this possibility. The papers of Mincarone et al.²⁷ and Fernández et al.²⁸ mainly focused on clinical processes, briefly addressing healthcare trajectories, resulting in a shallow analysis on this subject. Finally, Zarour et al.²⁹ targeted many BPMN extensions that could improve its effectiveness, but their research was not exclusive to healthcare settings.

Beside these preliminary relevant ideas, we adopted the JBI's Population Concept and Context (PCC) framework³³ to formulate the objectives and research questions, and to conceptualize the study and report characteristics in terms of eligibility criteria (**Table 1**). We then consulted with an expert on our predefined set of questions to provide further input and feedback.

In line with our purpose to comprehensively map the extent, range and nature of evidence examining the use or application of BPMN within the healthcare trajectory, we formulated four specific research questions to guide this review.

1. What are the objectives for using BPMN in healthcare organization? What are the expected results and what are the needs to be met?
 2. What are the key variables, elements, concepts, and dimensions targeted by the BPMN approach?
 3. Does the BPMN approach can meet these expectations in healthcare trajectory?
- a. What are the strengths (advantages) and weaknesses (limitations) of the BPMN in modeling healthcare trajectory?

- b. What are the effectiveness of using BPMN approach and its extensions in modeling healthcare trajectory? What are their opportunities and constraints in modeling healthcare processes?
4. What are the improvements or alternatives proposed to optimizing healthcare trajectory?

For the purposes of this review, the term healthcare trajectory focuses on the patient's care pathway across the continuum of care. Thus, it can be the clinical pathway when it focuses on the organizational scale, but also the care pathway when it focuses on the systemic scale. It consists first of the patient's journey through the sequencing of tasks and activities at all points of contact^{35,36}. It then integrates both the professional actors involved in the care trajectory^{37,38} but also the operation management of care delivery processes^{39,40}, the coordination structures⁴¹⁻⁴³, the structural context of the system and organizations^{44,45} and finally the information trajectory along the healthcare trajectory^{46,47}. Thus, our understanding of the term healthcare trajectory is not limited to the operational aspect of the care process and to the pathophysiological process of a patient's disease state, but also refers to the total organization of work done throughout all medical workers and patient interactions, as well as the effectiveness of patient care processes on those interactions and the organization.

Therefore, our analysis will consider both the potential and results from an operational perspective as well as from a social perspective by integrating the potential for improved patient outcomes including its impact on the patient experience. In addition, healthcare process mapping includes several different flows. On the one hand, the main process follows the patient's journey through the process steps and the decision points guide the patient through the process⁴⁸. On the other hand, the support processes and secondary flows include steps directly or indirectly linked to the main process such as administrative processes, information flow, organizational processes but also examinations that do not require the presence of the patient (e.g., laboratory results, pathological tests). Thus, several flows can be present and impact the care process (e.g., information flow, drug flow, blood flow,).

Therefore, this scoping review will focus on the potential of the BPMN on all its components that can directly or indirectly impact the results of healthcare trajectories. Finally, several proposals for extensions to BPMN have been put forward to integrate evidence-based medicine and guidelines to support clinical decision making. The main ones are the Decision Modelling Notation proposed by both the Object Management Group^{48,49} and the Computer Interpretable Guidelines^{50,51}.

Table 1: PCC framework³³ for illustrating the scope and defining inclusion and exclusion criteria of the review

	Inclusion	Exclusion
Population	Participants of interest are the healthcare stakeholders (knowledge users) involved directly or indirectly with the use of BPMN during the healthcare trajectory or clinical process. The healthcare stakeholders (knowledge users) will include patients, healthcare professionals (e.g., nurses, physicians, other professionals), administrators and decision-makers who were involved at least once in the healthcare trajectory or clinical processes (clinical or care pathways).	Literature that does not apply BPMN in health trajectory (e.g., healthcare process, clinical process, process of care, patient care process, healthcare trajectory, clinical pathways, patient care management). Since we are interested in the efficacy and limitations of BPMN in healthcare trajectory, this needs to be evidence-based (analyze a case clinical pathway) and not speculative.
Concept	The concept is the application of BPMN in healthcare trajectory and/or clinical processes to evaluate the BPMN capabilities to optimize the healthcare performance. Studies that reported any healthcare intervention and/or clinical processes modelling with BPMN, including the improvement of the quality-assessment and decision-making, the capability of understanding the internal clinical procedures, the ability to communicate those procedures in a standard manner, the ability to adjust to new internal challenges quickly and patients' outcomes will be included.	
Context	The context for this review will consider studies conducted in any clinical setting (e.g., inpatient, outpatient) or healthcare settings (e.g., hospitals, health centers, nursing homes). Studies conducted in any part of the world are eligible to be included in this review	Literature related to BPMN occurring outside of healthcare trajectory (e.g., clinical process, process of care, patient care process, patient trajectory, clinical pathways, patient care management)
Types of evidence	Reviews (e.g., systematic, or narrative reviews), peer-reviewed research articles, full-text articles are specific to modeling patient care trajectory incorporate the use of BPMN as a methodological approach and published in either English or French.	Studies published before 2004, not written in either English or French. Editorial articles, abstracts or posters, protocols for planned studies, strategy, or guidelines. Articles where full text is unavailable. Study do not indicate the use of BPMN as a methodological approach. Study focuses on other healthcare elements, such as professional development and performance management but not specifically on patient care trajectory.

Stage 2: Identifying relevant studies

A comprehensive search strategy was developed with the assistance of an experienced health sciences librarian (FB) at the Universite Laval. The search strategy will follow the three-step approach recommended by JBI scoping review guidelines³³ and will target the retrieval of both published and unpublished articles from electronic searches databases, focusing to BPMN modeling of patient care trajectory. The first step has been completed in preparation of this protocol, which involved an initial limited search on PubMed and ABI/Inform via ProQuest databases, using the following selected keywords: healthcare process, clinical process, process of care, patient care process, healthcare trajectory, clinical pathways, patient care management, and business process modeling notation, BPMN modeling.

The index words and the text words in the title and abstract of retrieved articles were analyzed to identify search terms for the next step.

In the second step, all identified keywords and index terms will be undertaken and adapted to each included information source (PubMed, EMBASE, CINAHL, Web of Science, ABI/Inform via ProQuest, Academic Search Premier, ScienceDirect, and Google Scholar) for potential eligible studies published in either English or French language, between the year 2004, the year when BPMN was initially developed by the Business Process Management Institute, and 2021. Third, we will also undertake the following five activities as part of the broad search strategy: electronic database search, web search, hand search of relevant journals (e.g.,) citations of relevant papers and scanning the reference lists of relevant papers. The final search results will be exported to Covidence systematic review software^{52,53} and duplicates removed. The full detailed search strategy and terms for the selected databases (PubMed, EMBASE, CINAHL, Web of Science, ABI/Inform via ProQuest, ScienceDirect) and grey literature sources (Academic Search Premier and Google Scholar) is included in **online Supplementary Appendix I**.

Stage 3: Selecting literature for inclusion

All retrieved articles will undertake two levels of screening. First, two reviewers (KSA and JBG or LL) will independently screen titles and abstracts of each article against the established inclusion and exclusion criteria (**Table 1**). To increase the reliability of screening by the two reviewers (KSA and JBG or LL), a pilot test will be conducted on 50 titles and abstracts to evaluate reviewer agreement in the screening process. Discrepancies will be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer (PL, CP, CL, or AC) will be consulted. Adjustments may also be made to the inclusion criteria if necessary to ensure consistent interpretation and application of the criteria. The researchers will discuss their selection of articles after this first round of screening, to arrive at preliminary consensus on the list of eligible studies. In the second step, the two reviewers will screen the full-text articles independently to determine if they meet the inclusion criteria. Reasons for exclusion of full-text articles will be noted in Covidence⁵³ by each reviewer. Reviewers will again discuss their selection of articles after this second round of screening, to arrive at a final consensus list of eligible studies. Discrepancies will again be resolved through discussion between the two reviewers and where agreement could not be reached, a third reviewer will be consulted. The screening process will be documented by calculating the inter-rater reliability between reviewers using the Cohen's Kappa coefficient⁵⁴ and a PRISMA flowchart for scoping reviews^{32,34}.

Stage 4: Charting of information and data

Data will be extracted from every eligible article using a data extraction chart (**Charting Table**) tailored to the research questions. Its aim is to maintain a manageable amount of data, while ensuring a wide approach and breadth of coverage to obtain existing evidence on the benefits and limitations associated with BPMN in patient care trajectory. Two researchers (KSA and JBG or LL) will independently extract the following study information: authorship, year of publication, country of origin, study purpose, patient care

trajectory issue being addressed (e.g., diabetes, chronic obstructive pulmonary disease, coronary heart disease, clinical pathway for contraception), study population/target users (e.g., physicians, clinicians, nurses, pharmacists), setting/location of intervention (e.g., primary care, acute care, rehabilitation, home care, long-term care, community, hospital), methodological approach (qualitative, quantitative, or mixed study), expected results study findings (e.g., decreasing diagnostic delay, optimizing of quality care, cost, reducing medical errors, standardizing decision-making process), type of outcomes/dimension analyzed (e.g., diagnostic times, waiting time for surgery, flexibility, improving key performance indicators, decision support system). We will note the objectives and benefits, as well the limitations of using BPMN approach. The proposed Charting Table is shown in **online Supplementary Appendix II**. It will be trialled on X and will be iteratively refined. Adjustments or expansions may also be made to the **Charting Table** if necessary to ensure that the research objectives or questions are well addressed. For instance, we may add additional categories of data deemed relevant to answer the research questions to the Charting Table.

Stage 5: Collating, summarizing, and reporting the data

The main findings of the included studies will be summarized in Tabular format in a manner that reflects the objectives of the review. Following the PCC principles³³, a narrative summary will accompany the Tabular results and link the different findings to the review objective and questions and will identify any knowledge gaps in the literature. To ensure rigour in this stage, two reviewers (KSA and JBG or LL) will prepare a descriptive summary table of the extracted data and will highlight the key findings with input from the research team. The Table will include a descriptive summary of the studies and a qualitative thematic analysis of the main results regarding characteristics of BPMN approach used in each study (e.g., objective, benefit, challenges, target users, redesign the clinical process), type of patient trajectory, characteristics of the research designs, outcomes of interest used to measure the effectiveness of BPMN (e.g., reducing work time, and challenges and potential solutions learned). We will identify barriers or limitations of BPMN for achieving improvement of healthcare processes, support activities and decision-making processes, and use that information to address our main objectives. The consultation stage of the scoping review, described in the following section, will contribute to fulfilling that objective and to establish a conceptual framework for improving the use of BPMN in healthcare trajectory. Finally, if the extracted data allow it, a qualitative analysis will be conducted to discuss or nuance the evidence of BPMN effectiveness considering potential barriers and enablers identified by the authors. We will use the PRISMA-ScR to guide the final reporting of our results.

Stage 6: Consultation with stakeholders

The final consultation stage offers an ideal mechanism to enhance the validity of the study outcome while translating findings with the stakeholders or health professionals. Preliminary findings from this review will provide the background for workshop with the research team and stakeholders/knowledge users (e.g., healthcare professionals, patients, decision-makers, administrators). The objectives of the workshop are to present and discuss the interim results of the synthesis. The meeting will generate a list

of key practice recommendations, dissemination strategy and research priority areas to inform future research. The Workshop will be conducted with the research team with a focus on reviewing the results following feedback from the previous meeting, reviewing the final report, necessary modifications to findings and recommendations for precision and clarity. These consultations with all stakeholders, including clinicians, technicians, and patients, aim to materialize the findings of this review by discussing their applications in specific contexts.

ETHICS AND DISSEMINATION

This scoping review is exempt from ethics approval because the work carried out will be based on published documents. The aim of this project is to synthesize the literature about healthcare trajectory using BPMN approach to enhance conceptual clarity and understanding about key benefits and limitations and to extrapolate from this evidence base promising conceptual framework for improving the use of BPMN in healthcare trajectory. We anticipate the research will provide several key outputs including (1) a comprehensive review that will summarise existing literature of BPMN approach; (2) Evidence base demonstrating the benefits and limitation of BPMN approach in modeling patient trajectory; (3) a list of BPMN extensions that can be used to improve its efficiency in many domains; (4) establishing a conceptual framework. Our findings will be disseminated in peer-reviewed journals and presentations and through discussions with relevant organizations and stakeholders. Our goal will be to disseminate our findings to a wide range of clinicians, leaders, and administrators in all sectors, to researchers and to students entering the healthcare professions to enhance understanding about key benefits and limitations of BPMN approach for optimizing the patient trajectory. We believe the results will benefit clinicians by guiding their decision-making throughout the patient's trajectory, therefore reducing the medical error rate, optimizing efficient resource management, and reducing the risks of complications due to poor clinical decision. Those improvements should result in an optimisation of cost-efficiency for the benefit of organizations, and quality of care should also be improved for the benefit of patients.

Funding

This scoping review is a part of a Postdoctoral project funded by Mathematics of Information Technology and Complex Systems (Mitacs).

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Declarations

Competing interests: The authors declare no competing interests.