

## BPM IN HEALTHCARE: PROCESS ANALYSIS FOR A HOSPITAL EMERGENCY DEPARTMENT

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### Abstract

This review discusses the use of Business Process Methodology (BPM) in the healthcare industry, specifically focusing on its application to emergency care processes. With increasing demands for better services and limited resources, healthcare providers are turning to BPM strategies to optimize patient outcomes, improve efficiency, and reduce costs. Process modelling offers several advantages in healthcare, including standardized clinical practices, improved communication, and decision-making processes. Despite the availability of Business Process Management Systems (BPMS) for over two decades, healthcare organizations still need to effectively utilize information and communication technology (ICT) to provide better patient services. The review evaluates the results of using the BPM methodology on emergency care processes and concludes that it represents a valuable tool for improving their effectiveness and quality. The findings suggest that the BPM methodology positively impacts the management and optimization of emergency care processes.

**Keywords:** Business Process Management, Business Process Modelling, Process Analysis, Emergency Department, Emergency Care Process

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## **Introduction**

This paper presents the application of a methodology called BPM (Business Process Methodology) to an Emergency Department (ED) of a public hospital, focusing on using simulation during the analysis and restructuring of processes. The public sector is increasingly required to provide better services at a lower cost, and healthcare is a core area for governments to improve performance while facing limited resources. This study focuses on the intricate process of providing emergency care, marked by extended periods of patient waiting, excessive utilization of emergency services, inadequate resources, and highly stressful work environments for staff. The approach demonstrates the usefulness of the methodology in analyzing and improving the emergency care process to reduce inefficiency, medical risk, and financial loss (Aronsky & Hoot, 2008).

The healthcare industry is experiencing rapid growth due to the implementation complex processes aimed at optimizing patient outcomes and improving efficiency (Buttigieg et al., 2016). To meet the increasing demand for care and technological advancements, healthcare providers are turning to business process management (BPM) strategies to analyze and redesign their processes, resulting in streamlined care delivery, reduced costs, and improved quality. Process modelling is becoming an integral part of healthcare management, as it facilitates a common understanding among stakeholders, supports digital transformation, and enhances care delivery (Reichert, 2011).

Process models can offer several advantages in healthcare. Visual representations of procedures can provide a user-friendly and easily understandable point of reference for training and communication among healthcare professionals. They are more precise and less prone to misinterpretation than written documents. Furthermore, they facilitate the adoption of standardized clinical practices and decision-making processes, ensuring adherence to agreed-upon protocols and reducing the likelihood of mistakes (Ferrante, 2016; Neumann, 2019). An effective response to emergencies is crucial in saving patients' lives, and properly integrated emergency medical services (EMS) can significantly reduce the risk of death or disability. Healthcare organizations constantly face various challenges in their daily operations, prompting them to seek optimal solutions to manage resources and provide high-quality services. In this context, adopting Business Process Management (BPM) in healthcare organizations has become increasingly prevalent.

Despite the fact that Business Process Management Systems (BPMS) have been available for more than two decades and the importance of continuity of care has been discussed for over 50 years, healthcare organizations are still struggling to effectively utilize information and communication technology (ICT) to provide better services to their patients. The lack or improper use of ICT and the rigid organizational structures of hospitals make it challenging to optimize processes using ICT. As a result, patients often experience long wait times, medical procedures may become impossible to perform, urgent results may be missing, and repeat tests and exams may be necessary. These problems often lead to longer hospital stays and higher overall costs (Reichert, 2011).

The automation process activities in healthcare have been effective in improving the management of patient information and clinical workflow related to information storage and retrieval (Khodambashi, 2013). This type of automation is less complex than automating entire processes and is focused on achieving operational benefits for specific parts of a process or individual activities. Examples include the use of BPM in Ilahi et al. (2014). The use of business process management (BPM) to model and enhance telemedicine and home healthcare processes (Ilahi et al., 2014), as well as the use of information and communication technology (ICT) to assist with clinical tasks such as diagnosis (Rijo et al., 2013).

Within this dynamic environment, the ED faces challenges such as extended waiting times, resource constraints, and high-stress levels, highlighting the need for strategic interventions. The primary problem addressed in this study revolves around the extended wait times experienced by patients in the ED. These prolonged wait periods not only contribute to inefficiencies but also pose potential risks to patient well-being. This research employs Business Process Methodology (BPM) as a methodological framework for the analysis and restructuring of emergency care processes within the ED of a public hospital. The primary goal is to reduce the often lengthy wait times experienced by patients, addressing a critical problem within the healthcare system. The findings of this systematic review aspire to contribute valuable knowledge to the healthcare field by offering a novel approach to managing and optimizing emergency care processes. The utilization of BPM, coupled with strategic analysis and restructuring, aims to enhance the effectiveness and efficiency of the emergency care delivery system.

## **Literature Review**

### ***A. Healthcare processes and CIG***

Medical informatics research has developed methods for computer-interpretable guidelines (CIGs) in recent years to help with the adoption of (guideline-based) decision support systems and to increase the accessibility and maintainability of narrative CIGs. Computer-interpretable guidelines are especially well suited for modelling medical treatment processes because they enable the representation and execution of clinical guidelines over specific clinical data of patients. (Peleg, 2013). One can officially represent and execute CPGs using an execution engine using methodologies based on task-network models, such as those used by Asbru (Shahar et al., 1998), EON (Musen et al., 1996), GLARE (Terenziani et al., 2004), GLIF3 (Boxwala et al., 2004), and ProForma (Sutton et al., 2003). These approaches also explicitly support the management of temporal aspects. CIG-based methods based on task-network models resemble imperative process modelling languages from a control-flow perspective (Mulyar et al., 2017). They mostly depend on specific modelling formalisms and execution environments as opposed to general-purpose, conventional BPM approaches, which, combined with the complexity resulting from their local adaptation, need to improve their widespread acceptance (Peleg, 2013).

### ***B. BPM techniques application used in the healthcare industry***

To support the modelling and execution of healthcare processes, standard-based methodologies have been developed in the BPM sector (Ferrante et al., 2016; Combi et al., 2017), mostly focused on prespecified and repetitive routines necessitating standardization. For instance, the necessity to combine medical procedures and health information systems is what led Ferrante et al. to develop their UML-based methodology. Combi et al.'s (2017) work instead focuses on the integrated design and implementation of decision-intensive care pathways in BPMN. Vanwersch (2014) presents a methodical redesign strategy for care processes by building on best practice process models. To coordinate interactions among healthcare processes based on business objects, Chiao et al. (2013) present an object-based solution based on the Philharmonic Flows framework. Although BPM techniques are useful for representing complicated and diverse procedures in the healthcare industry, their use in process modelling is currently limited.

### ***C. BPMN for healthcare process modelling***

As detailed below, researchers examine the advantages of BPMN for healthcare by applying it to certain medical scenarios. In order to view, comprehend, and enhance programmed surgical patient processes, employ BPMN (Rolón, 2018). The application of BPMN to model anatomic pathology processes is examined by Rojo et al. In their pilot study, Scheuerlein et al. (2012) sought to determine the benefits

of integrating BPMN with concrete business process modelling for the creation of clinical pathways for colon and rectum carcinomas. BPMN is utilized (Barbagallo et al., 2015) to model standard operating procedures and assess operating room planning and scheduling difficulties. Ruiz proposes one of the first studies looking at the usage of BPMN for modelling healthcare processes in general. They also outline the key difficulties that healthcare processes face (Ruiz et al., 2012). For example, the requirement to facilitate shared activities and multidisciplinary jobs are typical issues in modelling healthcare processes that the authors provide high-level insights into. In their research, Müller and Rogge-Solti (2011) focus on a single obstacle and explore various solutions to make it easier for BPMN (and its conservative extension) to be used as a shared working model in healthcare systems.

By modelling clinical pathways for catheter-related bloodstream infections using BPMN diagrams, Zerbato et al. (2015) emphasized portraying temporal restrictions, another essential yet challenging feature of healthcare procedures. They studied evidence-based decision-making, another problematic aspect. The technique advocates merging BPMN and DMN to represent decision-intensive healthcare processes originating from chronic care, and this study sets the framework for that methodology.

#### ***D. BPM for Emergency care process***

DiLeva and Sulis (2017) explore the use of Business Process Management to improve the operations of a hospital emergency department. The article describes the challenges faced by emergency departments, including high patient volumes, limited resources, and the need for quick response times. They then introduce the concept of business process management as a tool to improve emergency department operations by allowing for the identification of inefficiencies and bottlenecks in the patient pathway. Using a combination of process mapping, data collection, and analysis, the authors were able to identify areas for improvement in patient flow, resource allocation, and communication between healthcare providers. Based on their analysis, the authors proposed several changes to the emergency department operations, including implementing a triage system, optimizing staffing levels, and introducing a communication protocol for healthcare providers. The article concludes by discussing the benefits of process analysis for emergency department operations, including improved patient care and outcomes, reduced costs, and enhanced overall efficiency. Overall, the article highlights the potential benefits of using BPM to improve emergency department operations and provides a detailed case study demonstrating the application of process analysis in a real-world setting.

Dachyar and Pertiwi (2020) explore the potential of applying IoT to the Emergency Medical Service(EMS) process using the Business Process Reengineering (BPR) approach to improve the operations of a hospital emergency department. Based on their analysis, the authors proposed several changes to the emergency department operations, including optimizing staffing levels, introducing a real-time monitoring system, and implementing a data-driven decision-making process. The article highlights the potential benefits of applying IoT to the EMS process using Business Process Management technology for emergency department operations, including improved patient care and outcomes, reduced costs, and enhanced overall efficiency. Luise et al. (2022) analyze the use of the Business Process Model and Notation (BPMN) for the modelling in healthcare and highlight the challenges and best practices associated with its implementation. The authors argue that BPMN can model and analyze complex healthcare processes effectively, such as patient emergency care processes and administrative workflows, leading to improved quality of care and efficiency. The article outlines several challenges in using BPMN in healthcare, such as the complexity of healthcare processes, the need for interdisciplinary collaboration, and the lack of standardization in process modelling. The authors also provide best practices for overcoming these challenges, such as using a standardized

business modelling language, involving all stakeholders in the process modelling, and using a business process management tool for continuous improvement.

The authors provide several examples of successful BPMN applications in healthcare, such as modelling emergency department processes and optimizing hospital logistics. They also emphasize the importance of involving healthcare professionals in the process modelling to ensure that the models accurately reflect the real-world processes.

Mariem et al. (2017) propose using Discrete Event System Specification (DEVS) modelling and BPMN to capture healthcare process optimization, with a specific focus on the hospital emergency department. The article presents a case study of the application of DEVS in the emergency department of a hospital in France. The authors used DEVS to model the patient flow and resource utilization in the emergency department and BPM model to identify areas for improvement. The simulation results showed that increasing the number of nurses and physicians in the emergency department could significantly reduce patient waiting times and improve the overall efficiency of the process. The authors argue that healthcare processes are complex and dynamic and thus require sophisticated modelling and simulation techniques to capture their behaviour fully. They propose using DEVS, a formalism for modelling discrete-event systems, to capture the complex interactions and dependencies within healthcare processes accurately. The article highlights the potential benefits of using DEVS modelling and BPM for optimizing healthcare processes, particularly in the hospital emergency department. The authors argue that using sophisticated modelling and simulation techniques can significantly improve patient outcomes and resource utilization in healthcare processes.

Mejri et al. (2016) use a method for enhancing business process flexibility in emergency care processes. The authors present that the unpredictability of emergencies requires flexible business processes that can adapt to changing circumstances. They propose a framework that integrates process modelling, simulation, and optimization techniques to improve the flexibility of emergency care processes. The article describes the proposed framework, including the process modelling language used (Business Process Model and Notation), the simulation model, and the optimization algorithm (Particle Swarm Optimization). The authors apply their framework to a case study of an emergency care process in a Tunisian hospital and conduct several experiments to evaluate the effectiveness of their approach. They show that their approach can significantly improve the flexibility of the emergency care process, leading to better performance and higher patient satisfaction.

According to Juan López et al. (2018), The article provides a detailed description of the BPM implementation process in the health sector, including identifying key processes, analyzing process performance, redesigning processes, and automating processes using BPM software. The authors illustrate their approach with a case study of implementing BPM in a Colombian hospital. They show how BPM helped identify bottlenecks in the hospital's processes, streamline processes, and reduce patient waiting times. The article concludes that BPM can be a powerful tool for improving processes in the health sector and that its implementation requires a collaborative effort between healthcare professionals and IT experts.

## **Methodology**

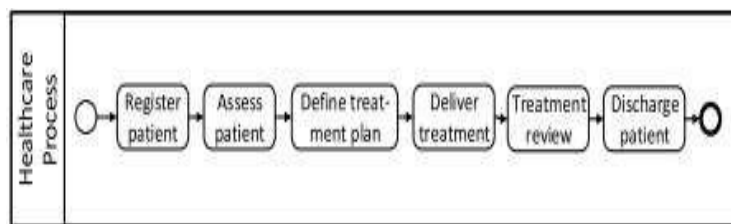
This review conducted a systematic literature search to investigate the application of Business Process Methodology (BPM) in healthcare, specifically focusing on emergency care processes. A comprehensive search strategy was employed across several databases, including PubMed, IEEE

Xplore, Scopus, Web of Science, and Google Scholar, using keywords related to BPM, healthcare, and emergency care processes. Data from selected articles were extracted and synthesized to provide insights into the impact of BPM in healthcare, as well as key challenges and benefits. While quality assessment tools were not explicitly mentioned, the review aimed to provide a comprehensive overview of the topic based on the selected literature, offering valuable insights for future research and healthcare practice.

**Process Analysis**

Emergency department overcrowding, where the number of patients waiting for service/treatment far exceeds the available capacity, is a significant concern worldwide (Buttigieg et al., 2016). Considering Sri Lanka as a developing country, waiting time for ED patients has increased due to high demand and limited resources (such as medicine, doctors, and beds). Specifically, the overcrowding of the Emergency Department shows an increase of 50% in Sri Lanka in the past. The COVID-19 disease spread in Sri Lanka since 2020 has been a significant reason for this rising demand. Chronic medical conditions, unsafe medical conditions, and an aging population can also contribute to overcrowding in these EDs (Ministry of Health, Sri Lanka). These factors have an impact on the patient and hospital staff. In addition to prolonged length of stay, it can lead to patient dissatisfaction and inappropriate care and can increase the risk of readmissions, medical errors, and subsequent deaths.

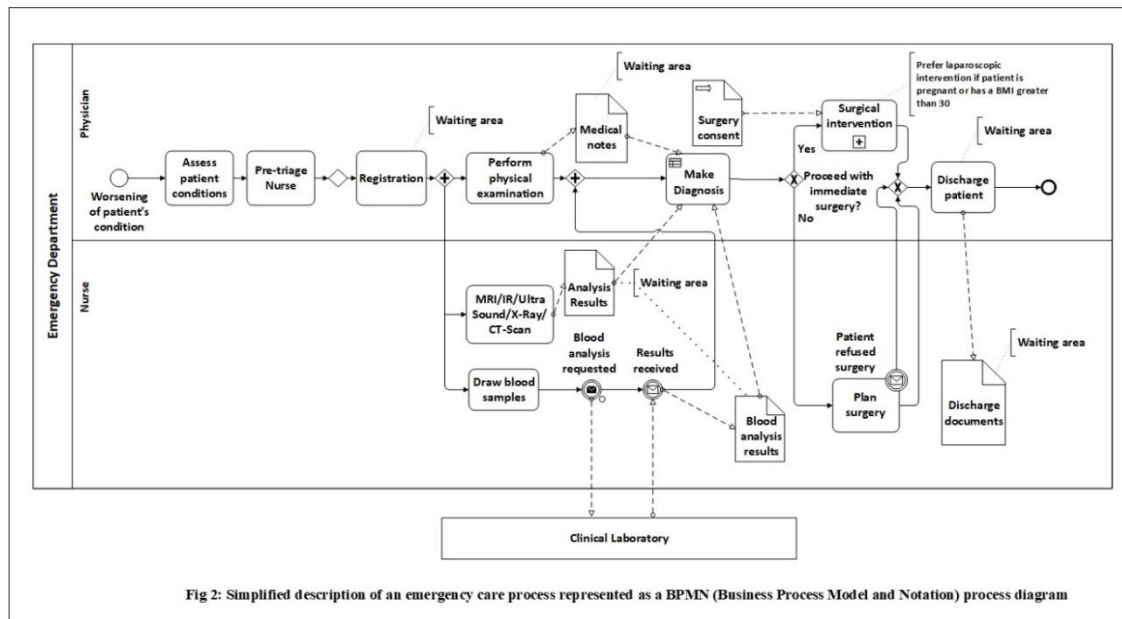
The emergency care process requires a thorough understanding of the current process and data that can be collected and measured. Therefore, a real-life case study of a public hospital located in mid-Embilipitiya, Sri Lanka, is considered to illustrate the proposed approach. The emergency care process in Sri Lanka can be described in five stages: registration, triage, examination, treatment, and discharge or transfer.



**Fig 1. Overview of healthcare processes**

An attending patient should attend all stages of the process except when the patient is highly critical (eg. injured and unresponsive, motor vehicle arrest, anaphylactic shock).

In this public hospital, As the first task, the patient enters the registration desk and begins the patient registration. There, the patient is classified according to acuity level. The triage nurses in the emergency department follow the hospital's established recommendations to classify patients into different levels of severity. Critically ill patients are prioritized in the hospitalization and treatment process based on nursing assessment, physician diagnosis, or the judgment of a treating physician. After the registration process is completed, the physician assesses the patient's condition. A nurse draws blood from the patient while the doctor performs the patient's physical examination. In a clinical setting, the diagnosis of a disease is determined by the physician based on the results of a thorough examination and blood analysis. If surgical intervention is deemed necessary based on the diagnosis, the physician performs the surgery with the patient's consent. The nurse, as part of the healthcare team, assists in planning the scheduling of the surgery. It is important to note that the patient can refuse the surgery, even if the physician recommends it. In the emergency department, the patient is discharged upon receipt of appropriate discharge documents. This process is typically carried out in accordance with established medical protocols and guidelines.



In the specific context of the emergency care process at this hospital, it is important to note that despite the adoption of Business Process Methodology (BPM) to streamline and optimize the patient journey, there is a significant concern regarding patient waiting times, especially at the registration desk and during the triage process. In this hospital, a quick registration process is not in place, and patients' waiting times may be influenced by their acuity level, impacting the overall efficiency and patient experience. As highlighted in the research article, the BPM methodology employed in this healthcare facility has simplified the emergency care process. However, patient waiting times, particularly during registration and triage and after the ED process is finalized, when patients await the preparation of documents and a decision on their destination (home or ward), or if the ED process is not yet finalized, leading to waiting in the observation area or waiting room, remain significant concerns. Addressing these issues through BPM strategies, such as improved resource allocation, streamlined workflows, and real-time monitoring, can further enhance the effectiveness of emergency care processes, ensuring that patients receive timely attention and high-quality care. This consideration is crucial, given the increasing demands for better services and the hospital's limited resources, as discussed in the review.

### Discussion and Conclusion

Extensive research has been conducted to mitigate the impact of overcrowding, patients' long wait times, overuse of emergency services, lack of resources, and high-stress work environments for workers in the emergency department (ED).

Previous studies have primarily focused on addressing the challenges associated with one or more stages of the emergency care process, including arrival, treatment, and discharge. These studies have aimed to identify and address the root causes of ED overcrowding, improving patient flow, reducing waiting times, and enhancing the overall quality of care provided in the ED setting.

The reasons behind crowding in emergency care can be traced to different stages of the process: the arrival, treatment, and discharge. When patients arrive at the ED, an increased demand for emergency services can cause overcrowding (Linden et al., 2017). While contributing factors like aging and growing populations are beyond control, others, such as high numbers of less severe cases, can be managed to reduce demand (Estey et al., 2003). During treatment, a lack of resources and delayed test results can slow patient throughput and lead to congestion within the ED. At the treatment stage, a shortage of resources (nurse, resident assistant, doctors, etc.) and delayed test results (magnetic

resonance imaging (MRI), interventional radiology (IR), ultrasound, X-ray, computed tomography (CT) scan) become the bottleneck, resulting in lower patient throughput, which then contributes to congestion within the ED (Bond et al., 2007). Finally, when patients are ready for discharge, delays in transitioning them to inpatient beds or homes can block access for incoming patients. These delays in transitioning patients to appropriate care settings can further contribute to ED congestion and overcrowding.

Researchers have explored various strategies and interventions to tackle ED crowding at different stages of the emergency care process. For instance, interventions targeting the arrival stage have included implementing triage protocols, improving patient screening and assessment, and enhancing communication and coordination among healthcare providers. Strategies aimed at the treatment stage have involved optimizing resource allocation, streamlining workflow processes, and improving the availability and timeliness of diagnostic tests. Interventions focusing on the discharge stage have included expedited discharge planning, improving communication with patients and families, and facilitating the timely transfer of patients to appropriate care settings.

The findings of this systematic review suggest that the BPM methodology represents a novel approach to the health field with a very positive impact on the management and optimization of the emergency care process.

### **Recommendations**

- **Implement Triage and Arrival Protocols:** Hospitals should consider implementing robust triage protocols to alleviate overcrowding at the arrival stage. These protocols should focus on efficient patient screening and assessment, ensuring patients are categorized based on their acuity level. Improved communication and coordination among healthcare providers at this stage can also aid in streamlining the patient flow.
- **Optimize Resource Allocation:** Addressing resource shortages, particularly at the treatment stage, is crucial. Hospitals should consider optimizing resource allocation by ensuring adequate nurses, resident assistants, and physicians are available to manage patient care efficiently. It includes addressing staff shortages, ensuring proper scheduling, and providing necessary training.
- **Enhance Diagnostic Test Timeliness:** Delayed test results from imaging modalities can significantly impact patient throughput. Hospitals should prioritize timely access to diagnostic tests, including magnetic resonance imaging (MRI), interventional radiology (IR), ultrasound, X-ray, and computed tomography (CT) scans. Investments in technology and streamlined processes can reduce delays and improve patient care.
- **Expedite Discharge Planning:** Delays in transitioning patients to inpatient beds or their homes can exacerbate congestion in the emergency department. Hospitals should focus on expedited discharge planning, including improved communication with patients and their families. Streamlined processes for patient transfers to appropriate care settings are essential to free up space in the ED.
- **Continuous Monitoring and Data Analysis:** Implement systems for continuous monitoring and data analysis to identify bottlenecks and areas for improvement within the emergency care process. Real-time data can help healthcare facilities make informed decisions and adapt quickly to changing circumstances, enhancing overall efficiency.



- **Invest in Technology:** Hospitals should consider investing in advanced healthcare information technology to streamline processes, facilitate communication, and reduce administrative burdens. Implementing electronic health records, telemedicine, and patient portals can enhance overall efficiency and reduce waiting times.
- **Interdisciplinary Collaboration:** Encourage interdisciplinary collaboration among healthcare providers, including physicians, nurses, and administrative staff. Enhanced teamwork can improve communication and decision-making, resulting in a more coordinated and efficient emergency care process.
- **Training and Education:** Provide ongoing training and education for healthcare staff to update them on the latest protocols and best practices. Training can also help healthcare providers adapt to the evolving demands of emergency care.
- **Research and Continuous Improvement:** Continue to conduct research and assessments to identify new strategies and interventions to address overcrowding and improve the quality of emergency care. Collaborate with other healthcare institutions to share best practices and lessons learned.

### Future Works

Based on the literature reviewed, the BPM methodology can indeed be a helpful tool in improving the effectiveness and quality of emergency care processes. However, it is essential to note that the successful implementation of BPM in healthcare organizations requires critical factors, such as effective communication and collaboration among stakeholders, strong leadership, and adequate resources, including the proper use of ICT. Therefore, future research could focus on identifying the critical success factors for implementing BPM in healthcare organizations and evaluating its effectiveness in other healthcare domains beyond emergency care. Additionally, further studies could explore the potential of combining BPM with other methodologies, such as Lean or Six Sigma, to improve healthcare processes.

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