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Introduction to BPM approach in Healthcare and Case Study of End User Interaction with EHR Interface

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Abstract

Nowadays, process management is a key factor in the success of organizations. The market in which the organizations operate is increasingly competitive. This increase makes the improvement of business processes a constant and essential need in organizations. In recent years, organizations increasingly choose to adopt Business Process Management (BPM) and try to use the Business Process Model and Notation (BPMN) to model their processes and, as a result, to make their systems and applications more interoperable with others. The Electronic Health Record (EHR) is another system for the exploitation of clinical and administrative information. Much of the information is generated in the EHR itself, the rest of the information results from external systems and are loaded into the EHR support database. This technology is a system with encrypted clinical information used in hospitals. This article looks at what BPMN is, and how BPMN can be a solution for an EHR. As a result, BPMN workflow diagrams of the system processes of the study case organization were created. The platform used in the case study is the Agency for Integration, Archive and Diffusion of Medical Information (AIDA) platform. Four main modules of the EHR were modeled; one of the modules was the ambulatory module.

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1. Introduction

In this day and age, to a hospital or any other healthcare institution, it is necessary to have a detailed and itemized management of all the processes involved, so that these organizations and their professionals can be, at all times, willing to do their service. Business Process Management (BPM) is already a solution used for process management in some of these healthcare organizations. The purpose of this solution is to improve an organization's business processes and organizational processes, in order to make the execution of the work fast and efficient and consequently, simplifying processes, reducing the use of resources and improving the accuracy of the work performed. BPM can also provide real-time process documentation and data, which is essential in a healthcare organization's services. In addition, systems that follow a BPM approach improve their interoperability between other systems and applications, that is, the ability of one system to interact and communicate with another, due to the more uniform process management. Organizations that adopt the practice of process-oriented management, require that their business processes must be previously modeled in a specific language [1]. Nowadays, there are several process modeling languages, such as Business Process Model and Notation (BPMN). The modeling of business processes, when applying the BPMN, allows organizations to obtain graphical representations of their processes [2]. Thus, organizations can anticipate the behavior of processes, perceive anomalies, inconsistencies, and inefficiencies in their processes, through the diagrams produced by the use of BPMN [3]. The business processes associated with the hospital resources are not clearly identified and formalized. Therefore, it became necessary to study why this happens, and what organizational practices are related to this factor. This article focuses mainly on the healthcare area, more specifically on the hospital processes of a healthcare organization, where good process management is required since it is an organization with a very complex structure. The health organization used for the study is the Hospital Center of Porto (CHP). As a case study, this article focuses on the application of the organizational practice of process-oriented management, BPM, in processes of a healthcare organization, using an Electronic Health Record (EHR), that uses BPMN process modeling language in a general context, and how it can be a solution for any EHR.

From an overview, the goal of this work is to improve business processes and document solutions already developed. In this article, the documented solution is the Electronic Clinical Process (PCE) of AIDA [4], where the inverse process is done, that is, it takes the undocumented solution and improves it with the help of BPMN. This makes it easier to see the solution in detail, allowing you to develop new functionalities in a more efficient and efficient way. For this work, the methodological approach used was a Research Design methodology, more specifically the Case Study approach. For this type of project, the technique used will be of a qualitative nature, since the attention is paid to the content of the collected data, such as personal meanings, intuitive approaches, among others [5]. This methodology encompasses case studies. The case study of this project focuses on the study of hospital processes in BPM models. The qualitative research part of the project is supported by the case study, thus allowing a broader understanding of the main concepts of the project. This kind of methodology captures the complexity of a simple case, usually applied to social and human sciences [6], contributing to a better understanding of individual phenomena and their organizational processes, as well as the form and motives that led to a particular decision to be taken [6].

The article is divided into four chapters, beginning with a general introduction to the subject in question (chapter 1). Subsequently, the most essential concepts to support the analysis of the subject in question is mentioned and described (chapter 2). Then, in the next chapter, an analysis of the overall solution of a PCE using BPMN is presented and detailed (chapter 3), following a section of discussion and analysis of the impact that BPMN will have in the organization in study, supported by good practices of BPMN and the other related matter (chapter 4). And finally, the last chapter comes with the will to reflect on the work done so far, together with an observation about what can be done in the future (chapter 5).

2. Background

2.1. Business Process Management, Business Process Model and Notation

The foundation of an organization is its business processes and how they are managed. Better management of business processes equals to an organization that is better able to achieve its goals. In general, a process is a path of ordered activities that transform an input into an output, and can consume or invoke resources, such as people or

materials [8], in a simple way, is the way things are done [9]. Management is a transversal function, which implies, it is a set of functions that manage and control the use of the resources of the organization and its operational activities. These management functions follow a cycle of planning and organization, which involves control, direction, budget and staffing plans [10]. And BPM is the application, it is the tool of this management cycle for the business processes of an organization [7]. BPM is a structured and systematic approach that aims to analyze, improve, control and manage business processes with the objective of increasing the quality of products and services, facilitating the creation of value as well as analyzing and improving fundamental activities such as production, marketing, communications and other fundamental elements of the company in a continuous way [11]. So, BPM makes the organization have a clear view of its processes and relationships with each other, in order to, successfully, create its products and services, making it a core part of an organization's current success. BPMN is a standard BPM notation, developed by Business Process Management Initiative (BPMI) [2]. Its main purpose was to get a rating that is easily understood by all business users, and besides that, BPMN is also able to create a standardized connection to the gap between the design of the business process and its implementation [2]. The purpose for the BPMN development was to create a simple mechanism to be able to create models of business processes [2] and at the same time, support the complexity that these processes of business carry [12]. In order to encompass these two aspects, the approach was to organize a graphic notation with specific categories [2], in order to be easily interpreted by any user. Within the basic categories, information and other variations of elements can be added to support more complex processes without drastically change the basic appearance of the diagram workflow [2]. The basic categories of BPMN notation elements are [2] Flow objects (Event, Task and Gateway), Data objects, Connection Objects (Sequence flow, message flow and association), Swimlanes (Pool and Lane) and Artifacts (group and Annotation).

2.2. Healthcare processes and organizations

Hospitals and other healthcare organizations face difficulties and problems in process management. These management problems can be categorized, namely: strategic problems, tactical problems and operational problems [13]. From a BPM perspective, problems at a strategic level, which are at the highest level of importance in the categorization of these problems, are related to process-oriented management, support and IT, organization of processes and administration problems [13]. The tactical level of problems addresses the difficulties in process modeling, measurement of process and methodological performance [13]. Finally, at the operational level, the problems are related to difficulties in the technologies that support process management [13]. Table 1 presents the general problems that fall within the categories mentioned above.

Table 1 - Major problems in different levels of organizations in process management (adapted from [13])

Strategic Level	Tactical level	Operational Level
<ul style="list-style-type: none"> • Lack of governance • Lack of training for employees • Lack of knowledge sharing • Connection failure between measures and organizational strategy 	<ul style="list-style-type: none"> • Lack of standards and norms • Process specification weaknesses • Lack of methodologies 	<ul style="list-style-type: none"> • Lack of support tools for process visualization • Gaps between process design and process execution • Lack of communication and tool handling capabilities

In a healthcare level, BPM is integrated in a way that works in parallel with hospital information systems, providing a critical and efficient environment that supports processes where doctors, nurses, managers and users interact. BPM also provides data, so that, reviews can be made to better understand where the failures occur in the processes when the expected results are not achieved [14].

3. Case study: BPMN modeling of end user interaction with EHR interface

Any health institution, such as hospitals, are organizations with a complex structure and huge interdependence, that is, their services are not independent and isolated from each other, but they are all interconnected, and they make the organization work, as a whole. The malfunction of a service interferes with the whole set of services and, consequently, the final result [15]. As mentioned earlier, health institutions are at different organizational levels, which ultimately

leads to poor management of their processes, and this is reflected in the organizations' performance. To combat these flaws, the BPMN application is an extremely reliable notation to standardize processes and is the process management practice most used by today's organizations. BPMN is the BPM's developed notation, created with the same purpose: to standardize the process modeling language and to make it simple and effectively understood.

As a platform applied to the health sector, EHR becomes an asset to apply the BPMN to it. EHR is a system for the exploitation of clinical and administrative information that has appeared due to the increase of the volume and complexity of medical information and the constant search for optimization of healthcare services. The EHR system helps in the processing, dissemination and storage of information, and also, assists in decision making, reducing errors and increasing the qualities of clinical services [16]. In order to correctly apply the BPMN, it is necessary, firstly, to make a detailed study of the platform, more precisely, it is necessary to understand the steps necessary to execute a given process and all its surroundings. In this aspect, it is necessary to analyze, as much detail as possible, so that it is possible to represent the processes independently of their level of complexity. The main factors to be analyzed and retained in the processes are how to trigger a process, that is, what causes the initiation of that process, the impact they have on the workflow of processes, what tasks are performed throughout the processes, who performs them, what kind of constraints emerge during the processes that can change their workflow and what types of connections and associations emerge during the execution of the processes. Once the platform has been studied, the next phase is the process modeling phase. The main modules in which the EHR focuses and which were modeled are: the ambulatory module, consultations, hospitalization and emergencies.

In Fig. 1 is presented the modeling of the process "View/Register patient's data", inserted in the modules of consultations, hospitalization and urgencies, as it is a subprocess.

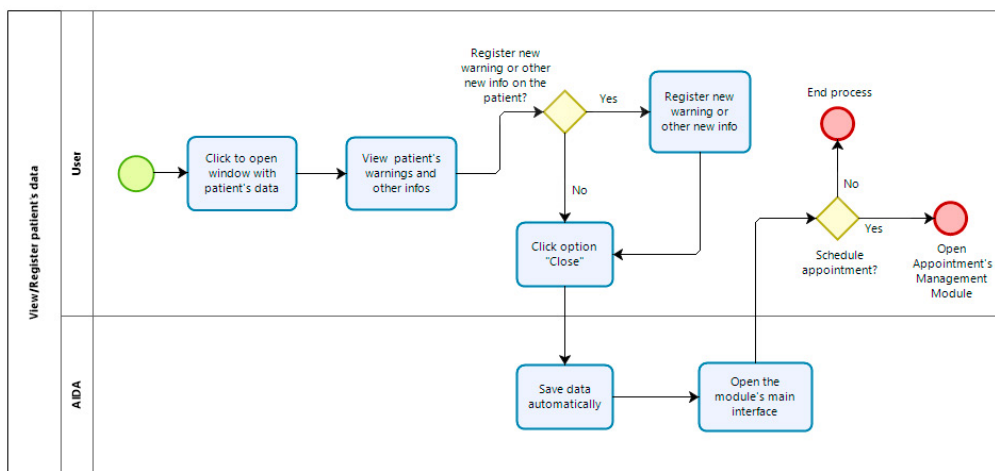


Fig. 1 - Example of a BPMN workflow process of EHR

The process in the example shown is triggered when the user wants to access the patient's data from the patient's list of the module that they are consulting. This happens when the user moves the mouse arrow over the name of a patient, hence the first activity that appears refers to accessing the patient's data. In this case, it means double-left mouse click to open a window of the indicated patient data. The user consults the warnings and other data presented by the patient's profile and then decides whether to register new patient information, which is why, a conditioner appears, hence the need to set up a gateway, to show that the process can follow two different paths: register additional information about the patient, if the user answers "yes" to the gateway conditioner, or otherwise, closes the window if the user responds "no". Once this activity is completed by the user, the EHR platform from Agency for Integration, Archive and Diffusion of Medical Information (AIDA) records the data entered automatically, whenever the "Close" option is accessed. Then, it immediately displays the main interface of the module to the user, as shown in the process workflow. Finally, another gateway appears, this time with the user's decision to schedule an appointment. As a subprocess, any of the decisions end the process indicated, but the decision made influences which process workflow will resume, as soon as this process ends. In addition to this functionality, the platform has more functionalities and

processes from which the following were also rewritten and modeled: appointment scheduling, login, hospitalization scheduling, records management and management of discharge clinic notes in the respective modules of the platform EHR. The last step is the implementation of the processes modeled in organizations, but this article will not cover that BPMN solution step.

4. Discussion

As a technology that acts in the healthcare area, EHR benefits in all aspects of its process management, using the BPMN solution, to standardize and improve its processes. The improvement of the hospital processes can not only become a factor in organizational success in the short and long term, as it can be a factor of improvement in the services provided by the doctors and nurses, and, consequently, contribute to an improvement in the treatment of the patients of the institution, as is the case of the study organization, the Hospital Center of Porto. Based on what was analyzed, the BPMN approach in the process management, will have an impact on the organization of CHP, at different levels such as: increase the level of quality in its services, greater ease in learning by new users, cost reduction and identification of losses or wastes that are occurring, and greater interoperability, that is, increased ability to communicate with other external systems, which will facilitate the exchange of business process information with other management tools. In addition, at the modeling level, BPMN is very intuitive, simplifying readings of complex processes' diagrams. The purpose of BPMN is, as already mentioned, to simplify and standardize the processes, but for this to happen, it's necessary to have an adequate modeling practice. The following list lists a set of good practices to be considered in process modeling when applying BPMN [3][17]:

- Avoid using more than one initial event in the process and a process can have more than one final event, but when this happens, use different names that match its final state;
- Descriptions of all events must be in the past participle;
- Subprocesses can be started with events of type "none", meaning, they that is not required that any specific event type occurs, in order to activate them;
- Always use start and end events to correctly signal the start and end of a process or subprocess;
- Link events must always have the same name and can only be used, within the same process;
- Use "link" events to avoid crossing lines in more complex processes;
- Use "terminate" events only to interrupt processes or subprocesses when parallel workflows occur;
- "Timer" events can be used in two different ways: at the edge of a task -indicating that the task has a specific execution time or between two tasks - indicating that there is a specific time of interruption between those two tasks;
- Activity names must be short phrases with a verb in the infinitive and within the context of the business;
- Do not use unusual abbreviations and avoid pronouns and articles;
- Gateways should always have a concise text attached;
- Gateways should only be used to represent the process flow. Gateways never represent facts or needs;
- Use the same type of gateway that diverged the flow to converge again;
- Input and output information of message flows should be clearly described;
- Avoid line crossings, maintaining a consistent workflow time and direction sequence. When this happens, the reading of the diagram becomes simpler and more efficient.;
- A pool can only contain a business process but can contain as many lanes as necessary to represent the participants involved in performing the different tasks of the process.

5. Final conclusions and future work

Healthcare institutions face difficulties and problems in the management of their processes [13]. For organizations of this context, complexity and importance that they have in society, it's necessary to make a detailed management of all their processes so that they can always be ready to provide their service with the highest efficiency possible.

The essential conclusion of this article is the impact BPMN will have on modeling and process management, and how this will affect the day-to-day life of the Hospital Center of Porto. Compared with what has been analyzed in previous articles and projects, the adoption of BPMN by organizations in the modeling of their processes is growing

fast, which shows that it is pleasing to the users that work with this notation. In addition to users, consequently, organizations benefit from adopting BPMN both at an organizational level, for example, by increasing the quality of their services and products, and economically, as organizations are able to reduce costs and detect possible wastes. The advantages derived from the use of BPMN increasingly appeal, to organizations that adopt this notation, to manage their processes and allow the dissemination of this tool in other areas.

The results obtained from this project were workflow diagrams of four EHR management modules of the Hospital Center of Porto, with this, it was possible to see how to streamline some processes and make them more uniform, so that a global solution could be found for a general EHR. These changes bring a lot of benefits to organization's process management such as optimization and simplicity of processes, better documentation, reutilization of information, among others. Furthermore, a correct modeling of the architecture facilitates its use, for the application of data mining models [18][19]. For the accomplishment of this article, the motivation factor was the fact that it was involved in the healthcare area and could be an asset for an elevated hospital in the country, such as the Hospital Center of Porto. The main challenge perhaps was to try to be the most cohesive in the argument that was given, in order to show that BPMN may be a solution for an EHR. In conclusion, in this article, a global approach is made that demonstrates a case study that can be replicated by any organization in any business area. This approach can have a significant impact in the day-to-day life of organizations, consequently, making a significant impact in society, in general.

As future work, it will be shown the work done so far with the organization under study so that it can be analyzed and perceive its opinion about the change in some of its processes.

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