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BPM AND BPMS AVALIATION IN A MAINTENANCE SECTOR OF AN INSTITUTION OF HIGHER EDUCATION

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Abstract

The *Business Process Management* (BPM) is an oriented methodology for the identification, design, implementation, documentation, measurement and control of business processes, making them flow from end to end. Thus, the activities and tasks cross the functional barrier to add value to the customer. This work presents a study of the implementation of process management in the maintenance sector in a Higher Education Institution (HEI), based on concepts from BMP, and supported with the implementation of a Business Process Management System (BPMS) tool. In addition, an experimental model management process was created, simulated based on real data available by HEI. The approach was proposed by Baldam et al. (2011), and the created process resulted from discussions and interviews with everyone involved. The work shows a simple, fast and didactic way of how processes can be modeled and evaluated by strategic levels of organizations, supporting easier decisions to implement the process management. In this case, indicators were identified that allowed an assessment of the advantages to control and manage organizational processes.

Key-words: BPM. Business Process Management. Modeling process. Simulation Process. Modeling tools.

1. INTRODUCTION

Ensure success and continuing growth of organizations are challenges in the global market. Due to internal and external pressures of the market, there is a need to develop a competitive advantage over competitors. Identify and analyze these advantages, transforming them into know-how for the organization, reduces risk and enhances the chances of development. The approach to process management helps identify, meet and improve working activities (Hammer et Stanton, 1999; Pradella, 2013). Traditionally prevail in organizations, the vertically integrated organizational structures, with visions and limited responsibilities to the universe of departments. Within the systemic approach (horizontal structure) the goals to be achieved, work processes and performance indicators are more easily identified, created and controlled. These elements can be used for a more optimal management of the company (Maranhão *et* Macieira, 2004).

BPM (Business Process Management) aims at the efficient and effective execution of business processes, helping organizations realize the transition from traditional management (hierarchical) to process management (Cruz, 2010). The process management is used for adding value and business leverage. To the extent that prioritizes the final customer reduces interference between functional areas and hierarchical levels. This is done through mapped and documented activities, the use of information systems and measurement of activities to evaluate process performance, and apply the concepts of continuous improvement for problem solving of different business (De Sordi, 2008; Kippera *et al.*, 2013; Soares *et al*., 2008).

According to the website of the National Institute of Educational Studies and Research Anísio Teixeira (INEP, 2010), the last census results of the higher education, conducted in 2010, show a trend in the growth in enrollment in courses graduation (in-person and online). In 2010it was estimated 6,379,299 students enrolled. Based on this, the Higher Education Institutions (HEIs) have expanded the range of services in the spheres of education (through undergraduate and graduate), in research activities and extension. Consequently, the physical structures of these HEIs had to grow along with the evolution

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of enrollment, requiring their services, equipment and facilities were always in good working order and conservation. For this, it is necessary that the maintenance activities were performed efficiently and effectively.

In the case of the University used in this study - called IES, from now on - it has a structure with more than 80 buildings between campuses and centers, more than 30,000 students and 3,000 collaborators, including teachers and employees. Its maintenance sector meets around 70 weekly maintenance requests to keep the operation of the structure appropriately. These requests vary widely with the type and size of the maintenance to be done, which requires a properly process formalized, efficient and agile.

This study presents the development and application of process management in the maintenance sector in a higher education institution, by using modeling tools and process management according to the BPM practices. The main contribution of the article is to show that, simply, existing processes can be optimized, formally modeled, and simulated in a real scenario. It is allowed to companies a more accurate assessment of the real benefits in the process management system as well as being a safer decision on changing their current processes.

The next section provides a review on the topic of process management. In section 3, the study scenario is presented, as well as the approach and the tool used in the study, followed by section 4 that presents the results achieved. Finally, Chapter 5 presents the conclusions from the study.

2. MANAGEMENT BY PROCESSES

2.1 Preliminary considerations

You can define a process as a set of ordered and integrated actions for a specific productive purpose, which are generated products and / or services for the care of their customers (Barbará, 2008). With a more formal approach, Davenport (1994, p. 7) defines process as "[...]a specific ordering of work activities across time and space, with a beginning, an end, and clearly identified inputs and outputs". In companies that provide services, the concept of processes runs off the factory model, ie, the manufacture, and goes to an intellectual content, making activities sequence less visible (for the customer and for employees) and increasing the importance of their understanding (Quinn, 1992). The procedure under analysis in this work involves exclusively the provision of maintenance services in general in an HEI. Although the final product not being tactile, the process itself has inputs, transformations, outputs and improvement possibilities, like any other(Barbará *et* Freitas, 2007).

Dávalos (2010) states that all both administrative and operational processes have a flow of inbound operations, processing and output, which involve the areas of organization, and human and material resources, considering all the activities inside or outside the unit of business and that add value to the final customer. There are different classifications and typifications for processes such as those addressed by Maranhão et Macieira (2004) and by Gonçalves (2000). However, in general, the processes are identified by three factors: the input, ie, all that will be manufactured or processed; the transformation itself of this raw material; and the assets, services or informations created (Figure 1).

The work in question involves the maintenance process of the campus infrastructure and the core of this institution, being related to the essence of its functioning, and critical to their competitiveness in the market and its business performance.

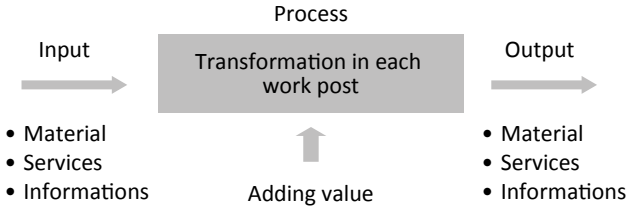

Figure 1 - Generic process model
Source: Elaborated from Maranhão *et* Macieira (2004, p. 12).

The literature presents different approaches on how to implement, manage, monitor and improve the business processes management (ABPMP, 2008;. Baldam et al, 2011; Campos, 2007; Jeston et Nelis, 2006; Santos et al, 2006;. Smith et Fingar, 2003). Business processes must be interconnected with the strategy and objectives of each organization, it is necessary in advance to spend adequate time for understanding the real needs of each stage, involving skilled people and contribute to this task (Jeston et Nelis, 2006) . These steps can be drawn through flow diagrams or flowcharts, for example, because it is a simplified language and representing the roles played by different process actors (Barbará, 2008).

Jeston *et* Nelis (2006) state that can draw the most effective and efficient processes in the world, but if people are not consulted, heard, trained, or do not understand how works the processes, these will not assume property to get involved and take responsibility.

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According to De Sordi (2008), companies that are managed by business processes give customer priority, using continuous improvement methods, valuing the work and empowerment of staff, ie, the autonomy of its employees. This reflects autonomy in decision-making that use all existing knowledge about the process, preventing that these determinations are merely acceptable and making them more appropriate to the case in its entirety (Baldam et al., 2011). Corroborating this line of thought, Costa (2009) states that the greatest advantage of process management is in understanding how things are done in the organization, demystifying issues, bottlenecks and inefficiencies that may be hidden within a process, aligning the role performed by each employee with the search for goals and the company's objectives.

Candido et al. (2008) proposed that the implementation of process management can be divided into four main initial steps:

1. Mapping of processes: prioritize the understanding of the organization in the current scenario;

2. Modeling of processes: to propose a future situation, a picture of an ideal scenario;

3. Disclosure of modeling: to present the proposal for those involved;

4. Implementation of modeling: developing a timeline of critical processes for the organization.

According to Maranhão et Macieira (2004), first we must understand and define the current situation of the company, called "the situation as is", arising from the expression "as is" in the English language. The next step is modeling the ideal process, or as it should be for that customer needs are met, adding value to the organization. This state is called "to be", or future situation. Between the current situation and the future there are gaps or differences that must be overcome to achieve the future state. These gaps are defined by Albuquerque et Rocha (2007) as strategic issues and may be current problems (loss of market participation), potential aggravating (falling market participation) or opportunities (launch of new products).

The concept of customer value is built from the perception of the advantages or the benefits he acquires in each of the transactions with the companies. The price paid for a good or service not always is the most important factor, it should take into account factors such as speed and convenience. Whereas conventional businesses were developed because of their own reality without focusing on the external customer, the cultural change becomes a way of survival, as the processes begin and end on the clients. That is, the processes begin with understanding what customers want and end with the acquisition of the good or service by the consumer (Gonçalves, 2000). Students of HEIs are characterized as being users of the educational services provided. So to go to college, need, besides skilled manpower (trained teachers), the physical resources (research laboratories, classrooms, public areas, libraries, etc.) are available and in working condition. This question increases in importance when it comes to a private organization.

2.2 Business Process Management

The Business Process Management (BPM) aims at the efficient and effective execution of business processes, helping organizations in the transition to a process--oriented view. With a more technical approach, focused on the area of information technology, Cruz (2010) characterizes BPM as a set of methodologies and technologies in order to enable business processes to perform the integration of customers, suppliers, partners, influencers , employees and the whole element with these can interact, giving the organization, an integrated and complete view of the internal and external environments of its operations. This integration can be done with the help of workflow software, which are designed to automate business processes. However, within a more current view, BPM can be defined as a management discipline, focused on improving corporate performance through the management of the company's business processes (Harmon, 2005).

Baldam et al. (2011) have adopted a model, illustrated in Figure 2, to describe the BPM methodology, considering four steps that comprise a BPM cycle. These steps are: BPM planning; modeling and optimization of processes; implementation procedures; and control and data analysis.

On the other hand, Cruz (2010) defines a generic life cycle for BPM based on the PDCA cycle (Plan-Do-Check--Act), composed of four phases, according to Figure 3: Initial analysis of needs; documentation, design and analysis of the current process; analysis, redesign, modeling and new process creation; and implementation of new process.

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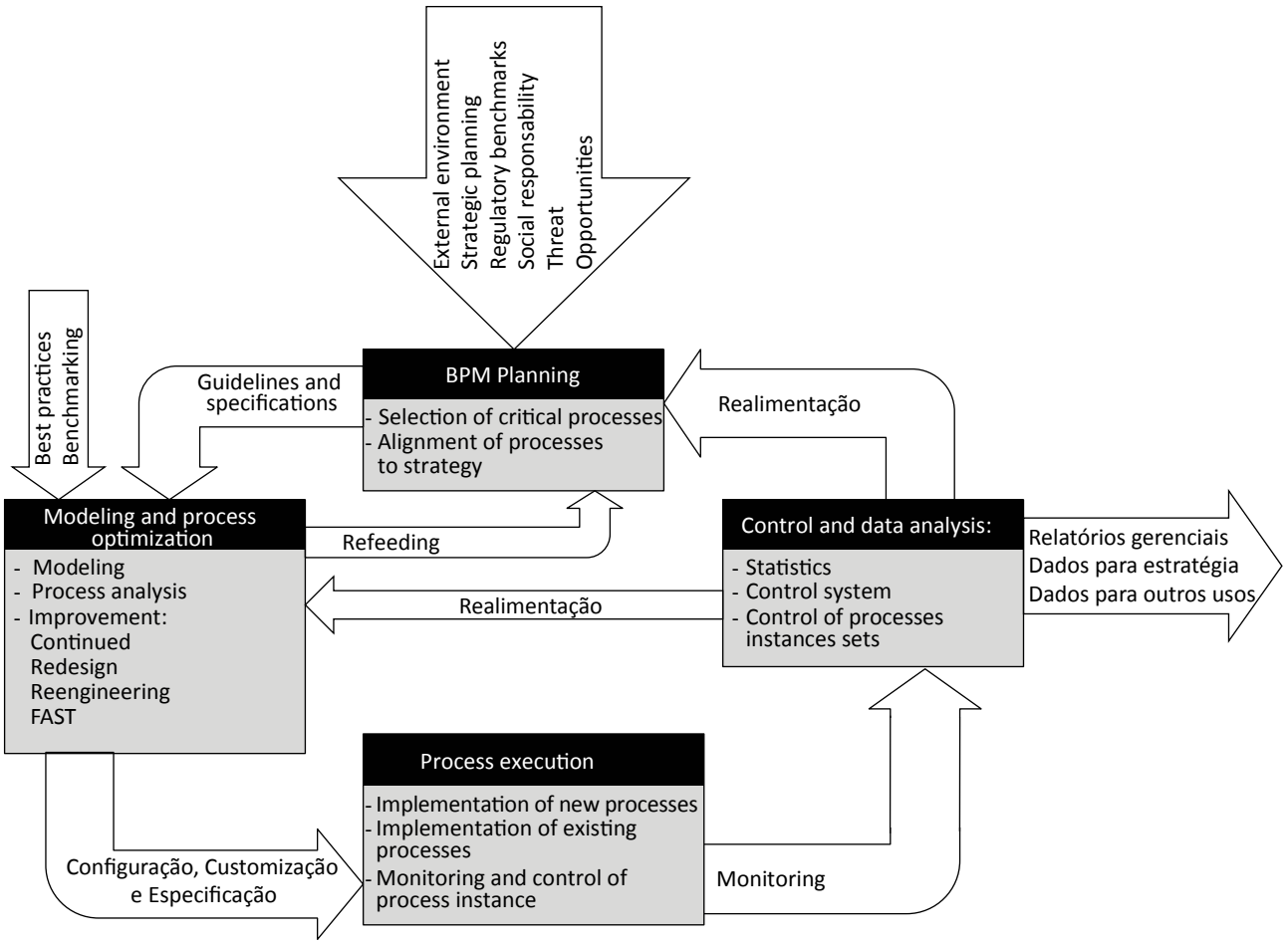

Figure 2. BPM cycle
Source: Elaborated from Baldam *et al.* (2011).

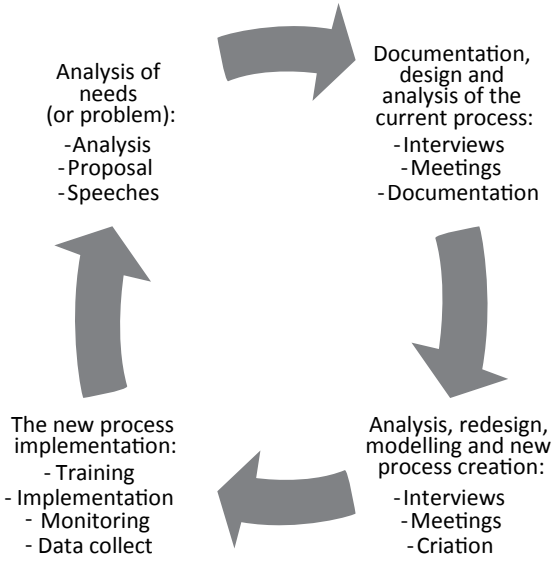

Figure 3 - BPM generic cycle
Source: Elaborated from Cruz (2010).

Confirming these ideas with the aforementioned authors, De Sordi (2008) shows two scenarios to be created in an organization that wants to use the BPM methodology: current scenario (as is) and proposed scenario (to be). Figure 4 summarizes the proposal of each author cited above regarding the BPM implementation.

2.3 Business Process Management Notation & Systems

Amaral et Britto (2006) define the BPMN (Business Process Management Notation) as a standard language for modeling processes in order to facilitate its understanding by all involved, approaching the areas of business to information technology department. According Junior et Scucuglia (2011, p. 50), "BPMN it is the largest and most widely accepted notation for process modeling. It is the most modern notation, with the adoption of a standard symbology that resolves a series of modeling gaps ".

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ESTAGES	Authors		
	Baldam et al. (2011)	Cruz (2010)	De Sordi (2008)
Selection of priority process	✔	✔	
Alignment of processes to the organization's strategy	✔		✔
Understanding of the current process	✔	✔	✔
Modeling of the current process	✔	✔	✔
Identifying opportunities	✔	✔	✔
Modeling of the proposed process	✔	✔	✔
Definition of indicators	✔		✔
Implementation and monitoring of the new process	✔	✔	✔
Data control and analysis	✔	✔	✔
Feedback process	✔	✔	

Figure 4 - Comparison of BPM implementation steps
Source: Own elaboration

The BPMN specification provides a graphical notation for representing business processes in a diagram. The objective of BPMN is to support the use of BPM by professionals, providing them with a very intuitive notation, but that can represent complex business processes (Baldam et al., 2011). You can divide the basic elements of this notation in four categories (OMG, 2009; BPMN, 2012): flow objects (events, activities and points of routing or decision); connection objects (sequential flows, message flows and associations); pools and rays; and artifacts (includes data objects, groups and annotation).

The BPMS (Business Process Management System) systems are software applications and information technology tools in order to establish the modus operandi of BPM, automating business processes, connecting people, managing change and orchestrating the process flow (Cruz, 2010). The growing evolution of business process management has created a large market tools to facilitate and automate the treatment of such process. These tools provide the support needed to build, document, analyze, organize, store and manage the information generated during the process. In this context, the concepts of BPM methodology, with the BPMS tool, assist in the identification, mapping, and collecting and recording this information (Barbará, 2008).

The consolidation and the evolution of process management concepts naturally led to the development of new technologies to support this type of management, for example, workflow, collaborative work (groupware) and enterprise application integration (or EAI), allowing tracking and monitoring of real-time activities (Albuquerque et Rocha, 2007).

However, according to Costa (2009), so that the BPMS systems are properly implemented, the communication between the information technology department and operating sectors should be aligned to the corporate strategy, providing all the hardware infrastructure and software needed for the control of processes, understanding how they work.

According to the website The BPM Experience (2012), there are 26 tools to support the implementation of the BPM available in the Brazilian market, such as: Intalio BPMS, BizAgi BPM Suite, Q-Flow, Oracle BPM Suite, among others. In this work, we used the BizAgi BPM Suite. This solution supports the BPMN language for process modeling and allows monitoring of the activities, the creation of business rules and support for supporting documentation (spreadsheets, charts, forms, etc.).

3. WORK PROPOSAL

3.1 Research environment

The higher education institution studied is located in the northeastern state of Rio Grande do Sul. According to the institutional information available on the HEIs website, the institution is composed of 9 units, distributed in its region,

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which includes a geographical area of 69 municipalities, reaching a population of more than one million inhabitants.

The maintenance sector has 21 employees, and 17 maintenance technicians, 3 administrative assistants and 1 coordinator. It has its office on campus Headquarters of the HEIs, responsible for providing services in all campuses. The services are related to electrical maintenance, hydraulical, telephone and electronic equipments, besides general repairs, such as building and electrical maintenance, equipment calibration and general maintenance of computer and research labs. The management of the activities is carried out through a virtual platform.

The administrative area is responsible for: management of service requests; emissions of invoices; bill payment; control telephone expenses; outsourcing; budgets; entry and exit of equipment; management of electricity bills; and other administrative services.

The main activities identified of the current process (year 2012) are described as follows:

a. is performed at the opening of the service request by the applicant (usually by the blocks office);

b. this request is registered in the Virtual System (Web platform);

c. the request is printed and delivered to the coordinator, which designed a technician responsible for the service. If outsourcing is necessary, it is indicated;

d. is recorded in the system the previous definition.

If the service is performed internally:

a. the printed request is placed on a control boardnext to a control document;

b. if the technician responsible for the service require any material, it must be requested from the central warehouse;

c. finish up the service.

If the service is performed by a contractor:

a. an employee of the administrative maintenance sector performs contact with the service provider requesting the budget;

b. it generates an open purchase request (without values), sending it along with the budgets requested to the purchasing department;

c. the purchase order is generated according to the most appropriate budget;

d. if necessary send the defective material for the service provider, emits an invoice output of the piece;

e. contact to the supplier to set the period of service delivery;

f. executes the service;

g. inspect the service;

h. the supplier sends the invoice for payment;

i. carried out the payment, and the process is finished.

In the current process, they are identified some points for improvement, such as: non-use of performance indicators and historical equipment; redundant activities; the overhead of some maintenance technicians; the large flow of printed documents; the absence of registration on the resources used for each completed service; and the absence of a clear way to identify where activities are stopped.

The modeling of the current process was based on interviews with employees of the maintenance sector and warehouse through document reviews and the system used for the management (Virtual System). It should be noted that, until then, there wasn't a functioning drawing of the current process. Were interviewed administrative assistants, the coordinator and maintenance technicians, as well as the responsible for central warehouse of the University.

3.2 Steps to the process management in the maintenance sector

For the implementation of this work, we used the approach proposed by Baldam et al. (2011) for being considered this approach clearly and directly than the other authors cited in the theoretical framework. Steps 2, 3 and 4 of the methodology were developed with the help of BizAgi BPM Software Suite.

3.2.1 Step 1 – BPM planning

This stage included analysis of the activities that contribute to the achievement of organizational objectives of the HEIs studied, specifically in the maintenance sector, through the survey of the main weak points of the current process and the identification of improvement opportunities.

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3.2.2 Step 2 – Modeling and optimization process

This step includes two major activities: modeling the current state (as is) and the proposed state (to be), which we used the BPMN notation:

a. modeling the current state (as is): construction of the model based on cognitive techniques, such as: analysis of current documentation, interviews and brainstorming with those involved in the process;

b. optimization and modeling of future state (to be): creating an environment of discussion between the parties involved (maintenance, purchasing, warehouse, suppliers and requesting users), with the objective of improving the process being analyzed. This is done by redesigning the current process through: reduction of bureaucracy and duplicated tasks; methods simplification; reducing cycle time; use simple language; activities standardization; definition of those involved in the process; definition of business rules; and use of automation with the use of information technology. At this stage, they are also identified benchmarks for this process.

3.3.3 Step 3 – Process execution

At this stage, it was evaluated experimentally by simulation, the proposed process. This was done by feeding the suite for performing the process by performing the following tasks: data modeling, generation of forms and definition of business rules and participants. The process execution engine ensures its implementation in accordance with pre-established rules at this stage.

3.3.4 Step 4 – Process simulation and analysis

This is the final stage of the work, in which process the benchmarks were analyzed with the objective of evaluating the proposed process. This allowed the identification of bottlenecks and flow traversed by each input among others. The resulting performance measurement information was used to process the feedback, reviewing the initial planning and again identifying improvement opportunities.

4. EXPERIMENTAL MODEL FOR MAINTENANCE PROCESS MANAGEMENT

4.1 BPM Planning

The initial stage of the study involved understanding the organization's objectives and the alignment of the organizational strategy with business processes, ie, become visible to everyone involved in the process, the horizon to be reached. Thus, the following elements were analyzed from HEIs studied: its vision, its mission and its principles.

The work proposed in this study meets the mission of the IES - produce, systematize and socialize knowledge with quality and relevance to sustainable development - in the category of knowledge production, through undergraduate and postgraduate courses, which need that the classrooms, the offices, the public areas and all the infrastructure offered are in working condition. Can be cited the example of maintenance in laboratory equipment as a way to demonstrate the importance of service, because they are directly linked to the production of a quality education. Despite its fundamental importance for achieving the goals of the organization, the current process faces a number of limitations, which were discussed in Section 3.1.

In order to limit the coverage of this study in its proposal, it prioritized the maintenance process associated with internal flows of the institution, i.e. those that do not trigger third-party service. Such an approach has been defined in terms of facility and availability of access to process data. Based on the knowledge of the guidelines of the HEIs and the limitations of the current process, we can then prioritize the points of analysis and go to the next step, which is the process modeling and optimization.

5. PROCESS MODELING AND OPTIMIZATION

5.1 Modeling of the current process

Five sectors were involved in the maintenance process: requesting sector, purchasing, suppliers (service providers), central warehouse, apart from own maintenance sector, which was divided into three areas: administrative, management and technical staff in order to facilitate understanding of current flow. Figure 5 shows the complete flow chart of the reporting process (called in this work of current process), illustrating the way that maintenance requests run and the activities performed. For the design of the flow chart, we used the technique Flowchart (ANSI - American National Standards Institute), which provided a presentation, an understanding and a simpler discussion by those involved in the process.

For this survey, interviews were conducted with all participants of this process, such as requesters, coordinator of the process, maintenance technicians, maintenance department, purchasing department and others involved. The focus of the interviews was to understand how each one saw the process as well as its activities within it.

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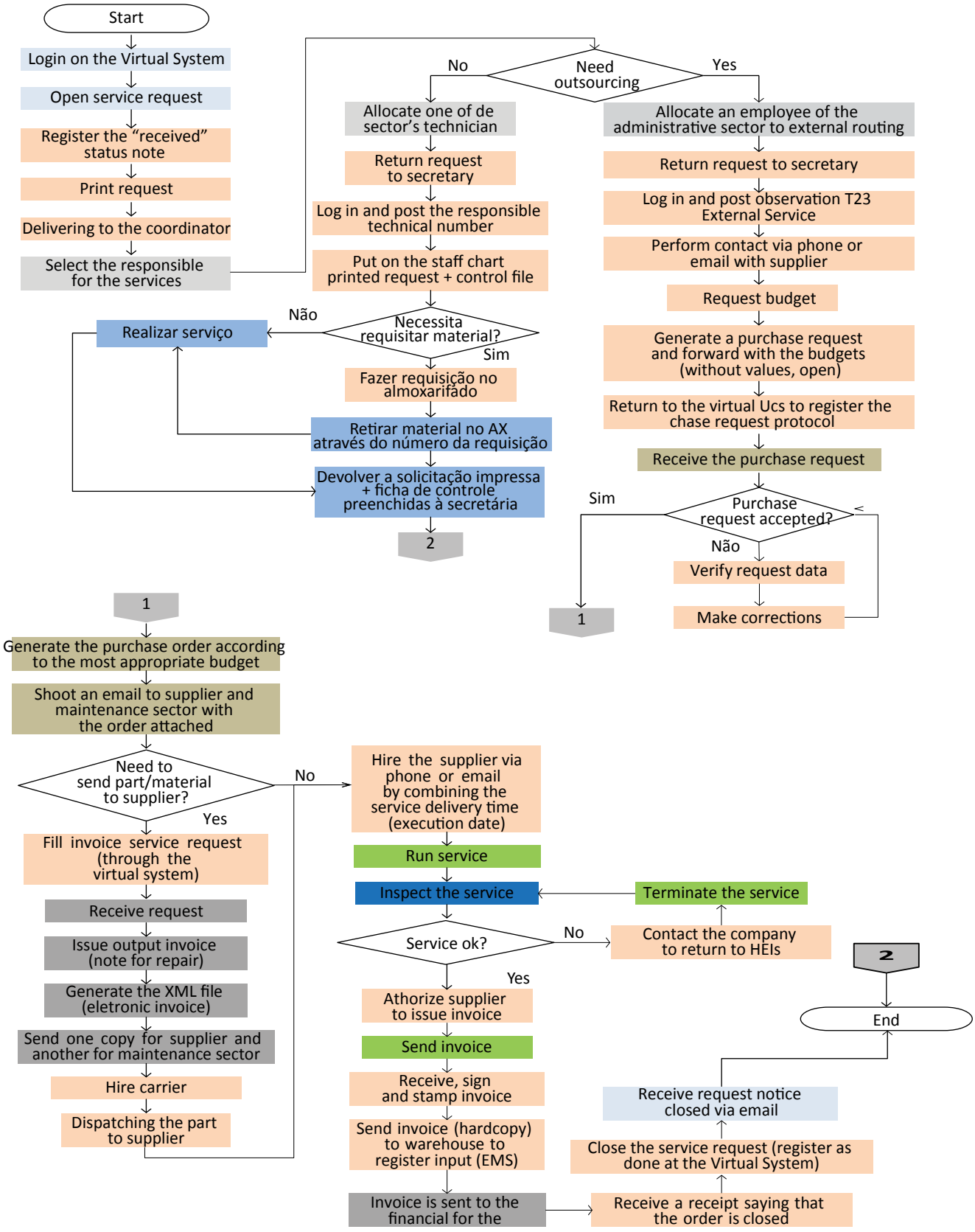

Figure 5 - Current flow of maintenance process

Source: Own elaboration.

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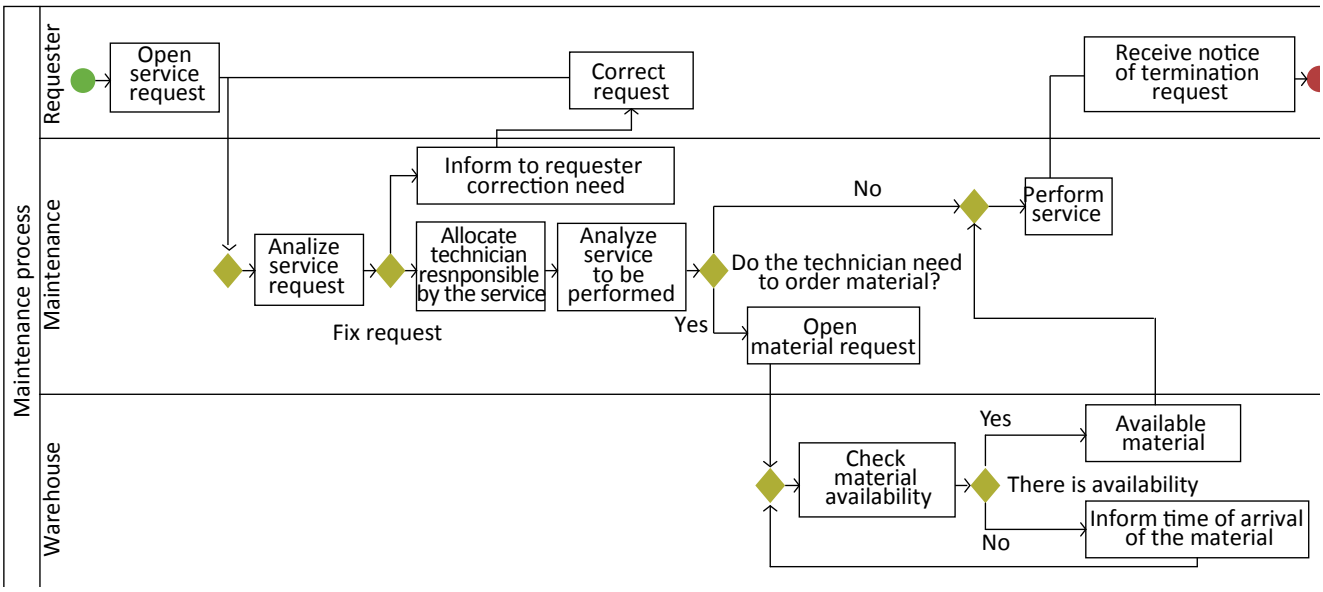

Figura 6 - DPN do processo de manutenção proposto

Fonte: Os próprios autores.

4.2.2 Modeling of the proposed process

Based on the analysis of the current process set-up the new process model, which is shown in Figure 6, through a Business Process Diagram (DPN). Three actors are involved in the process: requester, maintenance and warehouse. Following, presented the details of each one of the activities that make up this process.

The opening of the service request is the first step of the process, in which the applicant fills the opening form of the service request with the following information: service, subservice, problem description, phone, location and, if deemed necessary, can add comments. These are the necessary information for the understanding of what is being demanded by the client (requester). After filling the initial data, they are reviewed by administrative assistants in the sector in order to perform a filter of the information sent and make possible the return for the correction, if necessary. This return occurs through a mandatory questioning that the administrative assistant must answer. If the request is incorrect, it is returned to the applicant with some observations drawn up by the responsible for the analysis. This flow is repeated until the answer to the gateway "Request correct?" is positive, as shown in Figure 7 DPN.

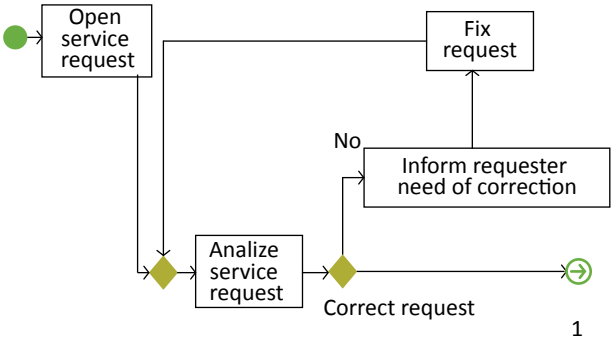

Figure 7 - DPN of the opening stage of the service request

Source: Own elaboration.

Compared to the previous process, by judging that the information was repeated or unnecessary, the following fields were removed:

a) sector and cost center: you obtain this information directly from the requester register;

b) expense cost center: This information becomes unnecessary because the costs will be allocated to the requesting user cost center.

After the correct completion of the previous stage data, the system automatically forwards the service request to the coordinator of the area, which is responsible by the indication of a technician responsible for service and able to perform the requested task, according to the service and subservice prefilled, as shown in Figure 8.

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With the number (ID) of the employee informed, the system forwards the request directly to the service technician, which displays in real time data for each request that is pending with him.

This coach will go to the location of the service and will consider the need to order some material for implementation, for example, request a lamp to be replaced. Then inform the code, quantity and description of the material. If you need to order material into warehouse, with the information registered previosly by the maintenance technician, one of the administrative assistants will open a request material using Virtual System and inform the code of this request.

With this new proposal, it eliminates the flow of print requests in the sector, which are subject to loss or forgetfulness on the part of the technicians or the coordination, leading to delays in meeting the required maintenance.

Figure 9 illustrates the step of requesting material which is directed to one of stockmans, which checks the availability of the material in the central warehouse of the University. If there is stuff in stock, it will make available to the technician. Otherwise, the stockman will need to provide a date for the arrival of the necessary materials.

The execution of the service is the last step in which the maintenance technician will perform the service, stating the dates of the beginning and completion. Therefore, it created a sub-process in which contains the various maintenance possibilities held in the HEIs. Thus, can be made the correct distribution of the load and the type of service. There are five maintenance service groups performed: hydraulic; electric; general services; telephony; and electrical and electronic equipment.

It should be noted that the activity "perform service" itself is not part of the system that manages the maintenance process, since it is a physical implementation of the work to be done. This activity, in this case, represents the actions associated with the appointment of the beginning of the end of the activity, as well as the type of activity to be performed, aiming to provide indicators that can enable the best sector to scale its technical crew.

After entering the end date of the service, the process ends, the applicant receives a message via email in order to evaluate the service and then terminate the process. The design of this process step can be seen in Figure 10.

4.3 Processes execution

With the proposed process patterned, the BPM Suite BizAgi was fed in order to enable the execution of the

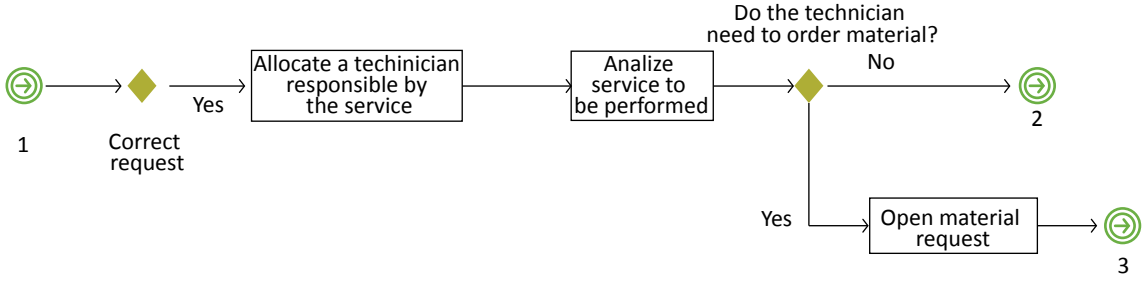

Figure 8 - DPN of the service responsible indication and verification of need of material

Source: Own elaboration.

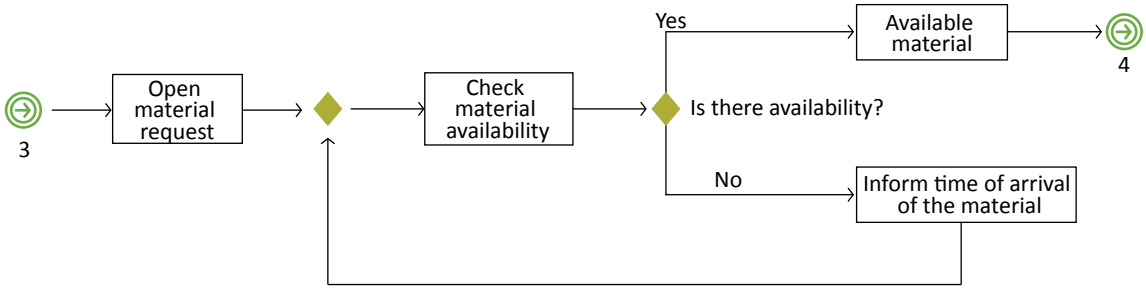

Figure 9 - DPN of the treatment of material requisition

Source: Own elaboration.

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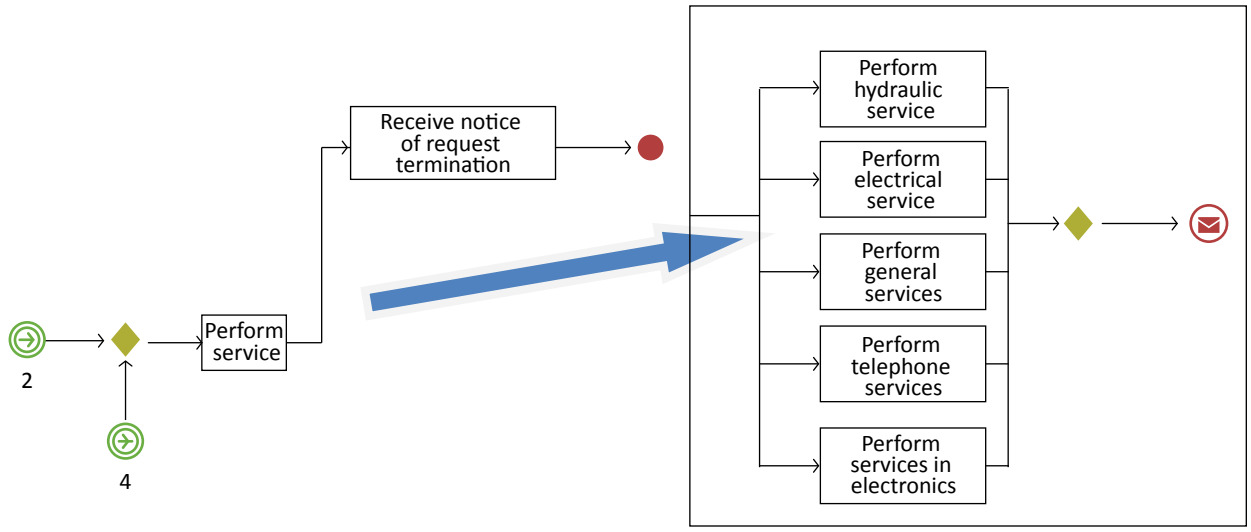

Figure 10 - DPN of the service execution and termination step
Source: Own elaboration.

experimental model proposed in a web environment. For this was necessary the creation of model of data, standard forms, business rules and definitions of participants in each activity. In this topic, are explained all the steps for the creation of experimental model.

4.3.1 Data model

The data model contains all the information required in the process and how they relate to the entities. To perform the simulation management of the maintenance process, the following information was required: service; subservice; problem description; local; phone; comments on the requested service; analysis of received data; observations on the need for correction of a request; technician name that will perform the service; check on the need of material request; description, code and quantity of required materials; code and date of the material requisition; check on the availability of materials; time of arrival of the material in the central warehouse; date of start and end of the service; considerations about the service performed.

Figure 11 shows the data model built, where you can check the links between the aforementioned entities.

4.3.2 Forms

Once set the process data model, the forms to be displayed to the users have been created. These forms were developed through attributes added to the master and parametric entities in the data model. Each activity has a specific form to be completed by the assigned user to do so. Figure 12 shows a specific example of the form used for the opening of a maintenance request.

4.3.3 Business rules

In this step, the process was configured according to the policies or rules of the organization. Each gateway defined in the process needs to be predetermined a condition to follow each path. For example, if the open service request is not correct, it will have to be returned to the requester, and to this is added a rule in this step of the process, which will return the request if the administrative assistant check the option “Service Request correct? = No “, which is shown in Figure 13.

4.3.4 Users

Was performed a register of all areas and all positions involved in the process, as shown in Figure 14. For each task, was designated a position responsible for its implementation. Only this person responsible for this position have access to relevant data to the activity that is your responsability.

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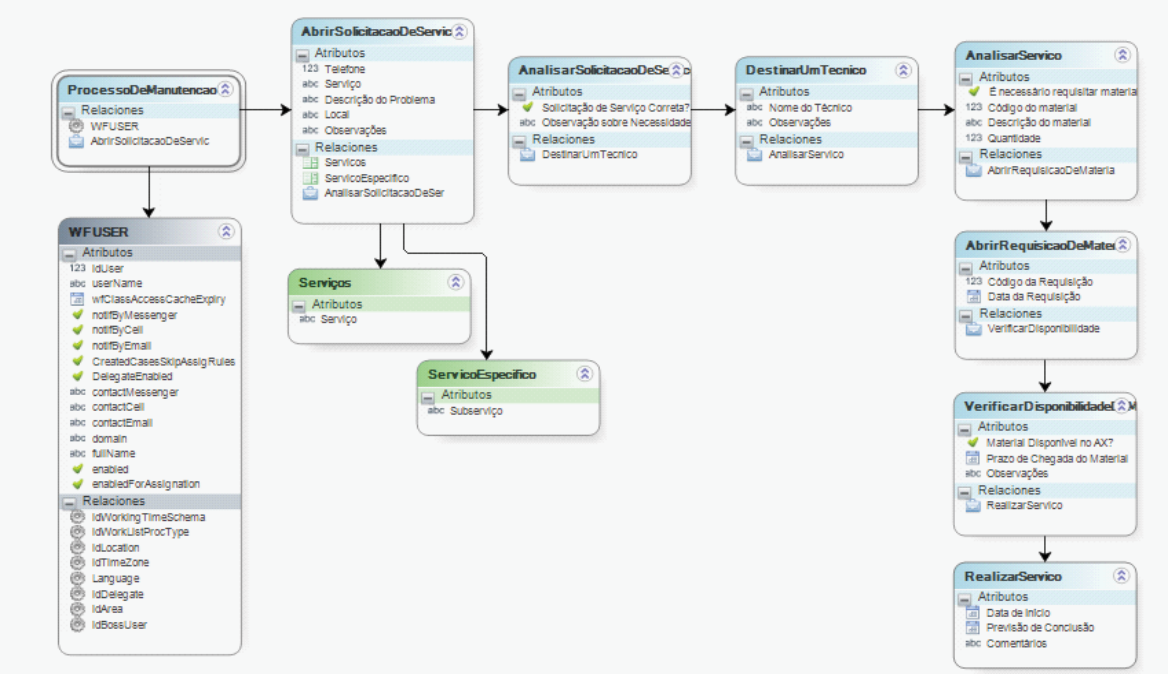

Figure 11 - Proposed data model

Source: Own elaboration.

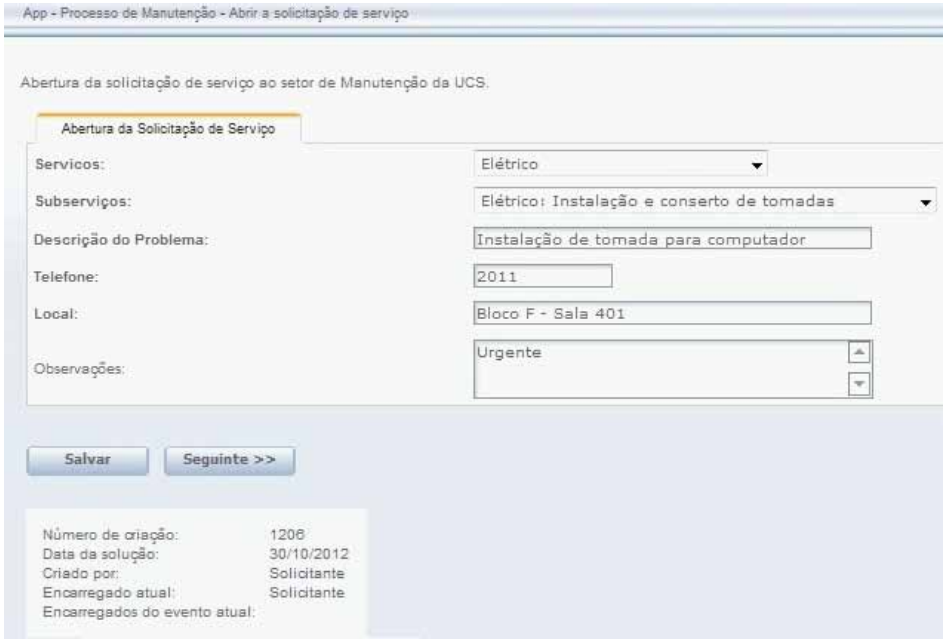

Figure 12 - Form for the opening of a maintenance request

Source: Own elaboration.

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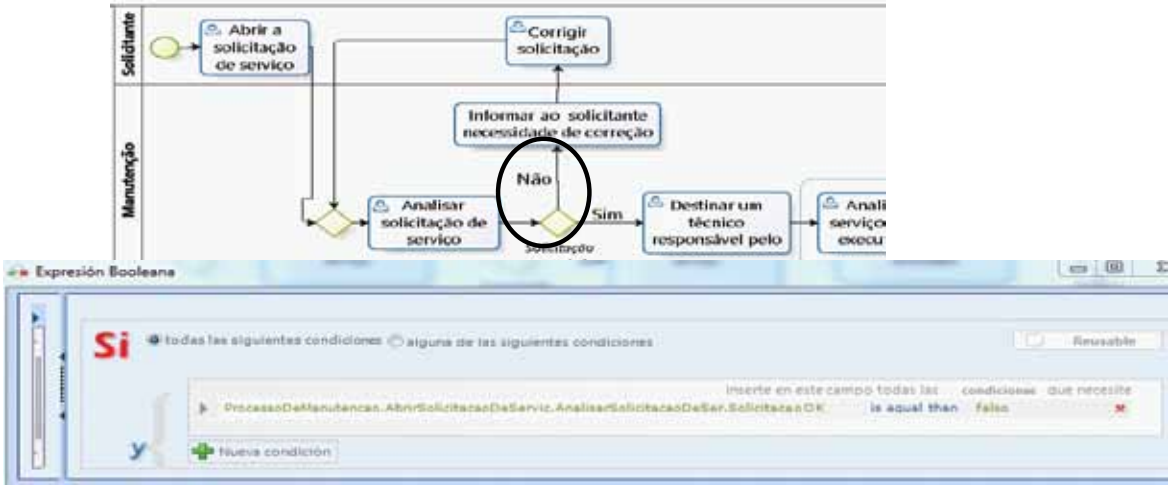

Figure 13 - Business rules
Source: Own elaboration.

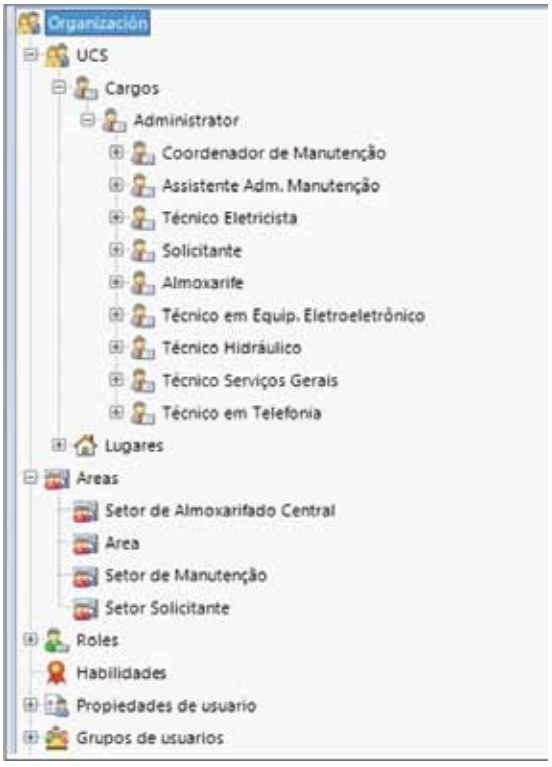

Figure 14 - Jobs and areas participating in the process
Source: Own elaboration.

4.4 Process simulation and analysis

The business process management combined with the BPMS systems enables complete monitoring and evaluation process. Through BizAgi BPM Suite software was built an experimental and manageable model of the maintenance process, which allows that the "process owner" gets access to updated in real time indicators. In addition, each user can know which activities are under your responsibility at the time.

This step includes the simulation of the process in a web environment and its subsequent analysis. For this, we collected 30 real maintenance requests, registered in the HEIs database studied in the period from October 1st to October 10th, 2012. These requests were included in the proposed environment, in order to analyze the benefits of applied management processes to the maintenance sector.

4.4.1 Process indicators

To make a manageable process, it is desirable that it contains the performance indicators. With the simulation process on a BPMS environment, specifically in BizAgi BPM suite, some indicators are highlighted automatically (by his own tool), such as:

a) Percentage of activities on time, at risk or delayed;

b) Number of close to expiration tasks;

c) Lead process time;

d) Processing time chart;

e) Summary table;

f) Opening trend of new processes;

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g) Running time of each activity;

h) Status of activities.

With the status indicator of the activities shown in Figure 15, it is possible to know how many activities are delayed relative to the total, considering the open processes, for example.

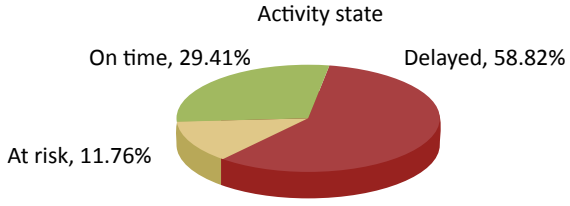

Figure 15 - Activities status indicator
Source: Own elaboration.

Likewise, the lead time process can be seen in Figure 16, along the standard deviation. For the calculation of lead-time, the system adds the time of each process after finished and divided by the number of cases closed.

Summary cycle time

Closed cases	12
Average duration	1.08 days
Estimated duration	0 days
Standard deviation	1.9574
Processes days	0

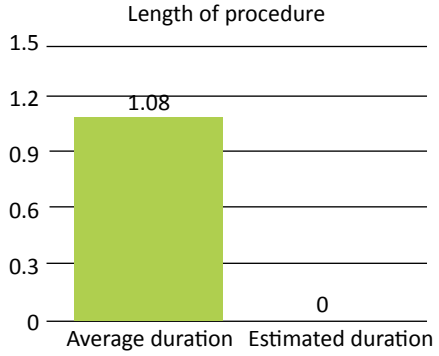

Figure 16 - Process lead time
Source: Own elaboration.

It can even obtain a summary table of activities, with the number of new processes and the number of completed and canceled cases, as shown in Figure 17. The system automatically calculates process efficiency by dividing the number of completed cases by the total .

Summary of process activity

New processes	51
Completed cases	12
Canceled cases	21
Efficiency	23.53%

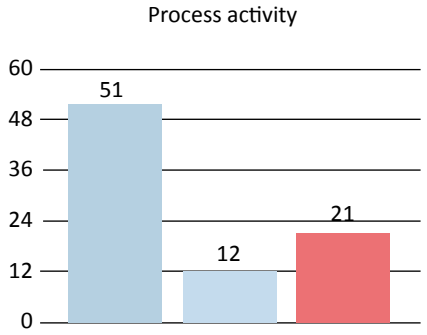

Figure 17 - Summary of process activities
Source: own elaboration.

In Figure 18, you can observe the average time to perform the task " destine technician for service", as the predetermined time, the amount of activities closed on time and delayed. With the individual analysis of each task, it is possible to identify what are the bottlenecks in the process, allowing focus efforts on tasks with low efficiency, ie with high delays index.

Other indicators such as the status of each activity and the time cycle of activities also can be viewed. For example, Figure 19 shows the execution times of the activity "Make Electrical Maintenance".

4.4.2 Process monitoring

In addition to the above-mentioned indicators, based on the experimental model and in its simulation, can be identified other aspects and information that facilitates the control and monitoring of the modeled process, such as:

a) Work Portal: that allows the user to know exactly which activities related to maintenance requests are under their responsibility, which is their deadline and the number of its creation;

b) Flow traveled by each process performed: that identifies how far the process has moved forward and which way he went, allowing users involved know what activity is currently running;

c) Responsible for the current process: that provides the current responsible for the process, date the re-

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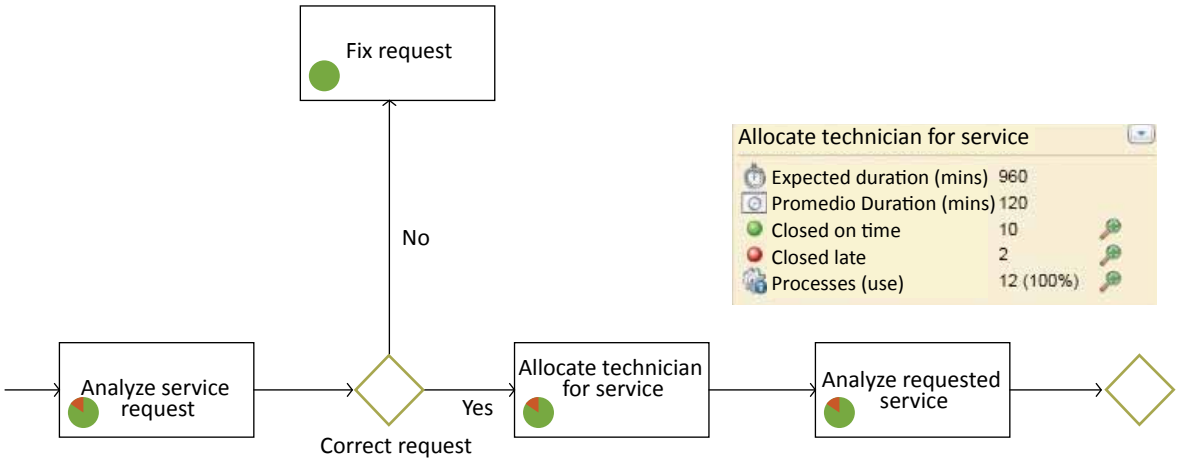

Figure 18 - Average duration time of activities
Source: Own elaboration.

Figure 19 - Activities cycle time
Source: Own elaboration.

ceipt of activity and the deadline for its implementation; and

d) Start and termination control of activities: in which the process owner can track, in the processes already concluded, who were the users who initiated and completed each activity.

4.5 Results evaluation

Some aspects should be highlighted in the work done for the validation of the proposed process, according to BPM methodology:

- Every business process must have a responsible, for example, a process owner. The function of this person is to ensure the efficiency and effectiveness of activities in its entirety. In the case of the maintenance process, assigned this role to the sector coordinator, due to his deep knowledge of the activities involved. This person has the responsibility to monitor the performance indicators and process monitoring tools in order to support any decision-making, focused on continuous improvement;

- With the mapping and process modeling, combined with the use of a BPMS system, any changes that arise in the flow of activities, with the objective of redesigning the process, can be performed without causing inconvenience to users while also providing time savings on that transition. The process owner can readjust the flow of activities quickly, through BPMS software without the need to trigger the institution's information technology sector;

- By diagramming each of the activities that make up the maintenance process using the BPMN notation, this is disclosed in a graphic, clear and standardized manner, allowing that all involved are aware of the whole and can contribute with suggestions for optimization process. The entire process flow is defined

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by business rules, ensuring that the activities are directed to specific users for each of the tasks and thus speeding up the progress of the process, avoiding that it remains stopped;

- Using the BPMS system, each participant knows exactly the tasks that must perform and when to perform them, as it has an automatic time control system of the activities according to the rules and expectations of time previously set by the process owner; and

- Finally, in the case of the studied process, the redesign of the flow of activities combined with the automation of these provided the reduced flow of roles in the maintenance sector, and a more streamlined process. Can be cited the example the analysis of requests that were previously printed by the sector's office and delivered to the coordinator. Also, a significant gain was obtained with the elimination of unnecessary activities, such as the time the coordinator delivers the maintenance request, printed and filled, with the name of the technician responsible for the service at the office again, in order to perform the postage in the Virtual System. The process automation allows the technician to be allocated directly by the coordinator, automatically receiving the request data for the execution of the service.

6. CONCLUSION

This work has shown the application of notation and method within the concept of management processes for the creation and evaluation of the maintenance process in HEI. From process mapping, it was possible to analyze and clearly define the process flow, revealing their reality and their improvement points, and make it visible to everyone involved. Furthermore, BPM practices applied to maintenance process reduced bureaucracy and made the process agile, standardized and adaptable to possible changes.

The modeling of the process, generated in BPMN notation, was the basis for the creation of an experimental model, which used a BPMS tool for the simulation of the proposed process. This model is a reference for future implementation of process manageable of maintenance, but requires the support of those responsible for the information technology sector, since it is a computerized and automated system.

Through simulation of the proposed process, it was noticed a greater agility on the flow of activities, and continuous monitoring by performance indicators. Such indicators allow greater assertiveness in decision-making, giving managers the full monitoring of the sector's activities, as currently there is no way to control the progress of maintenance processes, which makes the flow of activities unorganized.

The new process prioritized quality of service, to the extent that the maintenance sector receives a requesting user feedback before ending the process, giving greater credibility and reliability of services performed.

It has been shown also that the implementation of management processes in the maintenance sector is viable and that the objectives have been achieved, adding expertise to mappings that already have been carried out by the office processes of the studied HEIs. Thus, due to the benefits provided by this study, it is suggested to expand the concepts of BPM to other departments performing the integration of the current management system with a BPMS, the need to overcome existing cultural barriers in the organization, from a structured management hierarchically.

REFERENCES

ABPMP - Association of Business Process Management Professional. (2008). "Guide to the Business Process Management Common Body of Knowledge". Version 1.0. Initial Release.

Albuquerque, A.; Rocha, P. (2007). Sincronismo organizacional: como alinhar a estratégia, os processos e as pessoas. São Paulo: Saraiva.

Amaral, V.; Britto, E. (2006). "BPMN: o modelo E-R dos processos". Revista Disseminar on-line, n. 2, fev./mar. 2006, disponível em: http://www.iprocess.com.br/artigos/bpmn.asp (acesso em: 25 de Abril de 2012).

Baldam, R.; Valle, R.; Pereira, H.; Hilst, S.; Abreu, M.; Sobral, V. Gerenciamento de processos de negócios - BPM – Business Process Management. São Paulo: Ed. Érica Ltda, 2011.

BPMN – Business Process Management Notation. (2012). Object management group business process model and notation, disponível em: http://www.bpmn.org, (acesso em 20 de maio de 2012).

Campos, E.R. (2007). Metodologia de gestão por processos. Campinas: Unicamp.

Candido, R.M.; Machado e Silva, M.T.F; Zuhlke, R.F. (2008). "Implantação de gestão por processos: estudo de caso numa gerência de um centro de pesquisas". XXVIII Encontro Nacional de Engenharia de Produção, disponível em: http://www.abepro.org.br/biblioteca/enegep2008_TN_STO_070_501_11683.pdf, (acesso em 25 de março 2012).

Costa, L. (2009). Formulação de uma metodologia de modelagem de processos de negócio para implementação de workflow. 130 f. Dissertação de Mestrado em Engenharia de Produção. UTFP. Ponta Grossa, disponível em: http://www.

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DOI: 10.20985/1980-5160.2016.v11n2.699

pg.utfpr.edu.br/dirppg/ppgep/dissertacoes/arquivos/112/Dissertacao.pdf, (acesso em 30 de março de 2012).

Cruz, T. (2010). BPM & BPMS: business process management & business process management systems. 2. ed. Rio de Janeiro: Brasport.

Davenport, T.H. (1994). Reengenharia de processos. Rio de Janeiro: Campus.

De Sordi, J.O. (2008). Gestão por processos: uma abordagem da moderna administração. 2. ed. rev. e atual. São Paulo: Saraiva.

Gonçalves, J.E.L. (2000). "As empresas são grandes coleções de processos". Revista de Administração de Empresas. V. 40, n. 1, jan./mar.

Hammer, M.; Stanton, S. (1999). "How process enterprises really work". Harvard Business Review, p. 108-118, nov/dez.

Harmon, P. (2005). "Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals". 2nd Ed., Elselvier: Morgan Kaufmann.

INEP – Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2010). Censo da educação superior. 2010, disponível em: <http://portal.inep.gov.br/web/censo-da-educacao-superior/encontro-nacional>, acesso em 20 de março de 2012.

Jeston, J.; Nelis, J. (2006). Business process management: practical guidelines to successful implementations. Oxford: Elsevier, 2006.

Júnior, O.P.; Scucuglia, R. (2011). Mapeamento e gestão por processos: gestão orientada a entrega por meio dos objetos. São Paulo: M. Books do Brasil.

Kippera, L.M, Naraa, E.O.B, Mendesa, F.I. (2013) "Gestão por processos aplicada à gestão de projetos: uma metodologia para gerenciamento de projetos na indústria". Sistemas & Gestão. V. 8, pp 402- 414

Maranhão, M.; Macieira, M.E.B. (2004). O processo nosso de cada dia: modelagem de processos de trabalho. Rio de Janeiro: Qualitymark.

Barbará, S.; Freitas, S. (2007). Design: gestão, métodos, projetos, processos. Rio de Janeiro, RJ: Ciência Moderna Ltda.

Barbará, S. (2008). Gestão por processos: fundamentos, técnicas e modelos de implementação: foco no sistema de gestão da qualidade com base na ISO 9000: 2000. Rio de Janeiro: Qualitymark Editora Ltda.

OMG – OBJECT MANAGEMENT GROUP. (2009). Business process model and notation (BPMN). Version 1.2, disponível em: http://www.omg.org/spec/BPMN/1.2/, acesso em 21 de maio de 2012.

Pradella, S. (2013). "Gestão de Processos: uma Metodologia Redesenhada para a Busca de Maior Eficiência e Eficácia Organizacional". Revista Gestão & Tecnologia. v. 13, n. 2, p. 94-121, mai./ago.

Quinn, J.B. (1992). Intelligent enterprises. New York: Free Press.

Santos, A.G.; Cruz, G.M.; Santana, M.R. (2006). Modelagem de processos de negócio para instancias governamentais. Salvador: UFBA. Monografia (Programa de residência em software), Universidade Federal da Bahia.

Smith, H.; Fingar, P. (2003). Business process management: the third wave: the breakthrough that redefines competitive advantage for the next fifty years. Tampa: Meghan-Kiffer Press.

Soares, E.P.C., Duarte, M.D.O., Almeida, A.T. (2008) "Planejamento de Sistemas de Informação baseado na metodologia BSP: um estudo do caso DETRAN/AL". Revista Eletrônica Sistemas & Gestão. V. 3 (3) 163-177