Supporting digital transformation using Business Process Management: Proposal of a digital tool

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Abstract

Growing demands for globalization, integration, consistency, innovation and efficiency alongside digital technological developments have drastically increase the interest in business processes. In this field, Business Process Management (BPM) emerged as a tool to facilitate the standardization in digital transformation methods, as it helps to clarify new processes and, consequently, to propose technology-based solutions. In this paper, a conceptual framework on business process management that culminated in the development of a digital tool to support digital transformation in an industry-specific context is presented. The proposed solution contributed to an increase in processes' standardization, monitoring and interconnection, making processes more efficient and with high levels of communication, performance and transparency.

Keywords
Digital Transformation; Information Management; Business Process Management; BPMN; Power Apps.

1. Introduction
In recent decades, the industry has undergone changes at all levels of action. New processes and product technologies emerged, management methodologies were reinvented, customer expectations and needs were modified and the quality and quantity of suppliers in the market increased (Ahuja et al., 2006). In addition, the global market has become highly competitive and getting the right product, at the right price and at the right time is not only the basis for competitive success, but also a necessity for survival (Aitken et al., 2002). This forced organizations to analyze their processes (internal and external) to detect problems, waste and activities that do not add value.

In order to improve their processes, organizations have found the need to move towards a digital transformation through the implementation of new innovative business models, optimizing operations and applying digital technologies such as cloud, social media, embedded devices, mobile, analytics and Internet of Things (Brown & Brown, 2019; Dumas et al., 2012; Scholz et al., 2018; Von Rosing & Etzel, 2020).

The scientific community has extensively investigated the challenge related to digital transformation in companies (Cândido & Santos, 2015; Jacquemont et al., 2015; Von Rosing & Etzel, 2020). Managing change, especially digital and/or technological change, is not always easy. Thus, it is very important to reduce risks and costs and maximize the benefits of such major changes in business. In this field, Business Process Management (BPM) is a very important and relevant tool to manage and document the workflows of companies (Kraljić et al., 2014; Rajabi & Lee, 2009).
This paper presents a study, carried out in a Portuguese company, with the main goal of developing and implementing a digital tool to support information management. Making use of the Business Process Model and Notation (BPMN), this tool evidences the organizational changes that are occurring in the company as it moves towards digital transformation.

The paper is structured as follows. Section two presents the literature review, where concepts such as Digital Transformation, Business Process Management (BPM) and BPMN are specified. Then, in the third section, the study developed in an industry-specific context is described. At last, in section four, the main findings and future lines of research are presented.

2. Literature Review

2.1 Digital Transformation

Digital transformation is happening every day, all around us, driven by the need of integrating new technologies and machines, alongside with the need of facilitating horizontal and vertical integration along the value chain (Ustundag & Cevikcan, 2018). It is characterized by the representation of real-world objects or processes in the form of digital symbols (Scholz et al., 2018), using technologies to solve specific issues (Dumas et al., 2012). These technologies are operating and changing all levels of human systems. They materialize in the form of machines that master digital representation, computing and adapting related to environmental information (Scholz et al., 2018).

Due to its numerous advantages, digital transformation is quickly becoming a top priority for organizations (Dumas et al., 2012) and there are high expectations regarding the digital transformation in industries all around the world (European Commission, 2020).

In order to facilitate the digital transformation in organizations, Von Rosing and Etzel (2020) introduced a Digital Transformation Lifecycle which provides a sequence of phases that can be can followed by any practitioner, regardless of the industry type or the size of the organization. The lifecycle has four distinct phases (Understand, Innovate, Transform and Continuously Improve), each one well defined. Depending on the cases, the main phases can be divided into sub-phases, as shown in Figure 1.

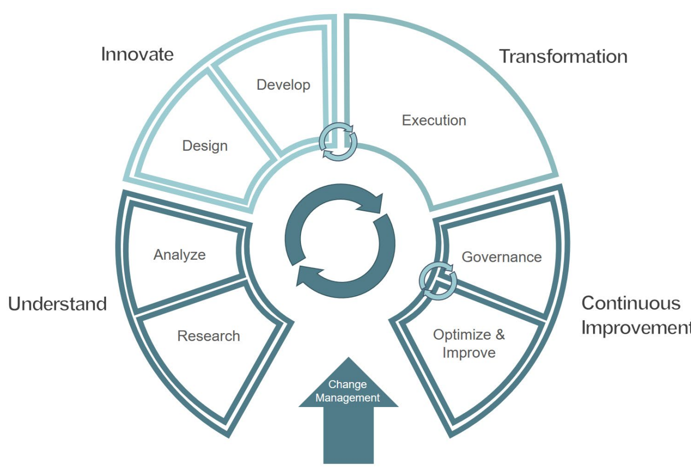

Figure 1 - Overview of the Digital Transformation Lifecycle (Von Rosing & Etzel, 2020)

Thus, to implement a sustained digital transformation, Von Rosing and Etzel (2020) propose a process going through the following steps:

I. Understand Phase:

  a. Research - understanding expectations, detecting risks and exploring emerging trends in industry.
  b. Analyze - identification of forces (external/internal) and relevant roles.

II. Innovate Phase:
  a. Design - determining objectives and critical success factors, propose a business strategy, diagnose risks, align stakeholders and select resources.
  b. Develop - quantify risks, create business plan, arrange and enhance resources.
  Moving to the third phase without innovating will typically lead to a solution a lot more digital but with very little business transformation. According to Von Rosing and Etzel (2020), this is the main reason why digital transformation initiatives fail to deliver what is initially proposed.

III. Transformation Phase:
  a. Execution - applying measures, implementing application's solutions, developing processes and conducting standardization and integration.

IV. Continuous Improvement – in this phase the value realization is optimized and/or improved under a systematic approach:
  a. Governance - control of ongoing operations' measures, monitoring, identification of problems, challenges and problematic points.
  b. Optimize & Improve – identification of change drivers, assessment of the potential for change, development of change roadmaps and specification of options and solutions for change.

2.2 Business Process Management (BPM)

A business process is defined as a set of related procedures or activities, performed by people or machinery, in a predefined order, with the aim of delivering value to the customer (Dumas et al., 2012; Kraljić et al., 2014; Zur Muehlen & Indulska, 2010). Business process models are constructed using Business Process Management (BPM) techniques or notations (Zur Muehlen & Indulska, 2010). BPM can be defined as "a discipline involving any combination of modeling, automation, execution, control, measurement, and optimization of business activity flows in applicable combination to support enterprise goals (…) within and beyond the enterprise boundaries" (Von Rosing et al. 2014).

Business Process Modeling is a powerful approach that has been providing benefits in areas such as data-driven decision-making, technology integration, increased growth and stability, standard process models or cross-department synergy (Zur Muehlen & Indulska, 2010).

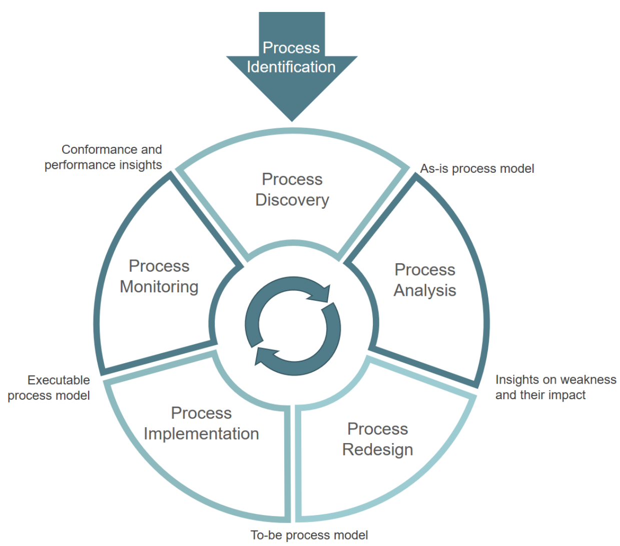

Figure 2 - BPM lifecycle (Dumas et al., 2012)

In 2004 the Business Process Model and Notation (BPMN) was presented as a standard for modeling business processes in a graphical/flowchart notation. The objective was to bridge the gap between business analysts and Information Technology (IT) systems while also filling the gap between business process design and implementation

(Kraljić et al., 2014; Rosing et al., 2012). BPMN is designed to be easily understandable by all business stakeholders (Rosing et al., 2012).

The Business Process Management (BPM) lifecycle provides a highly useful sequence of steps that any stakeholder can follow during a process-oriented project (Von Rosing et al., 2014) (Figure 2). As with the Digital Transformation Lifecycle, each step uses the results of the previous one to achieve a predetermined goal.

The BPM lifecycle has six distinct phases:

I. **Process identification** – outlines the processes that are relevant to the problem, delimiting their scope, identifying relations between them and developing performance measures indicators.
II. **Process discovery** (also called AS-IS process modeling) – clarification, characterization and documentation of all relevant related information objects, properties and relationships of the relevant process. At this point, a visual representation of the identified process is developed, typically, in the form of AS-IS process models.
III. **Process analysis** – identification, analysis and quantification of the issues in the AS-IS process. During this phase, the analyst seeks for opportunities and ways to improve the process.
IV. **Process Redesign** (also called process improvement) – identification and analysis of potential remedies for the issues discovered in the previous phase. At this stage, the analysts propose a reformulation of the existing process through reengineering or design of a TO-BE process.
V. **Process implementation** – set of activities required to change the way of working of all participants involved in the process and (re)configuration or implementation of an IT system to support the TO-BE process.
VI. **Process monitoring** – collection and analysis of relevant data in order to determine how well the process is performing. Anytime, new issues may arise, in the same or in other processes, which requires the cycle to be repeated on a continuous basis (Dumas et al., 2012; Von Rosing et al., 2014; Zur Muehlen & Indulska, 2010). Continuous improvement is a key aspect of BPM whereby feedback from the process and the customer are evaluated against design performance measures (Von Rosing et al., 2014).

2.3 BPM as a Tool to Support Digital Transformation

Organizations have found extremely challenging moving towards digital transformation for several reasons, including a lack of standardized implementation protocols or the large-scale implementation of digitalization without a realistic view of return on investment (Dumas et al., 2012). The emergence of many technologies in a short period of time is also making companies feel confused, lost and even misunderstood. Even after deciding to implement digital systems, organizations consider problematic the lack of strategic guidance and the uncertainty about the outcomes in the matter of benefits and costs (Ustundag & Cevikcan, 2018).

Major reasons for the rejection of digitalization methodologies by organizations include fear of the unknown and resistance to change, whereas the use of business process management (BPM) can mitigate them by giving manufacturers a sense of familiarity, as shown in the work of Antonucci et al. (2020), Butt (2020), Castro and Teixeira (2021), Fernandes et al. (2021), Von Rosing et al. (2014), and Salvadorinho and Teixeira (2021).

Having reliable and robust IT systems is an important part of an effective digital transformation, but it also requires attention to multiple variables such as easy, flexible and simple to use systems and information (Brown & Brown, 2019). Moving forward with digital transformation processes without correct information management can become confusing for companies and cause serious problems. The scientific community has extensively investigated the challenge related to transformation in companies and, according to the McKinsey Global Survey, in 2015, only 26% of respondents reported that the transformations they were most familiar with have been very or completely successful at improving performance over time (Jacquemont et al., 2015).

Information modeling may result in a single integrated enterprise information system with well-defined information models, covering the strategic, tactical and operational tier (Von Rosing et al., 2014). Business processes are the backbone of the most developed Information Management systems (such as ERP's) and BPM has become a key factor when integrating a process driven enterprise due to the ability to provide a common understanding and analysis of the business processes. In fact, according to Kraljić et al., (2014), the unsuccessful attempts to implement an information management system are directly related to a lack of use of business process models and notations.

3. Development and Implementation of a Digital Tool in an Industry-specific Context

3.1 Industry-specific Context and Methodology

The study presented in this paper was carried out in the Innovation Department of an industrial company in Portugal. The department is highly important in the company's activity since it is responsible for the development of new products (which will be called prototypes) and technologies.

For the company to remain competitive, every day different prototypes are produced in order to develop new products to be commercialized, which have to have the expected physical and chemical characteristics. Contrary to what is usually found in the industry, there is no mass production or continuous production in the Innovation Department, since different prototypes and different tests are carried out almost every day.

The methodology followed in this study was based on the BPM lifecycle described by Dumas et al. (2012), Von Rosing et al. (2014) and Zur Muehlen and Indulska (2010) and the Digital Transformation Lifecycle proposed by Von Rosing and Etzel (2020). The objectives of the different phases of each lifecycle meet at several points and, in Figure 3, below, a way to apply both lifecycles in a single project is represented.

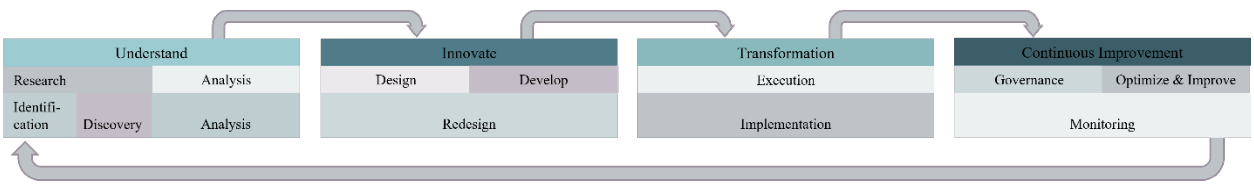

Figure 3. Methodology followed in the study, based on the Digital Transformation Lifecycle and the BPM Lifecycle

3.2 Problem Contextualization and Goals

The Innovation Department has a 'project production' type of production, characterized by a significant degree of complexity and diversity. Figure 4 presents the innovation funnel, which is the macro process under analysis in this paper. The (successful) projects go through seven main stages: ideation, value proposition, concept, test, industrialize, launch and post launch. In this study, the test phase will be analyzed in detail and modeled according to BPMN rules.

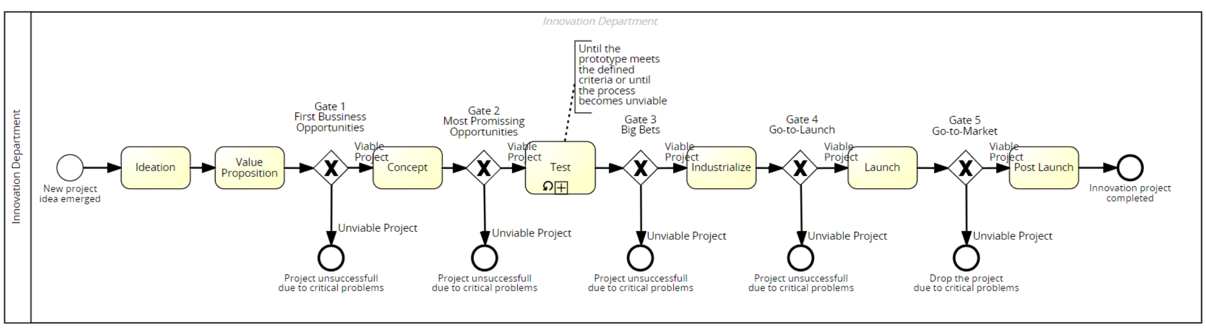

Figure 4 – Innovation Funnel

Considering the high diversity of processes, the standardization of procedures is a complicated task. Even though the scale and complexity of projects is increasing, most project information is stored in unstructured documents. The data about the prototypes produced and the tests carried out is stored in multiple excel sheets or even on a sheet of paper that may end up lost. The consequences of this are several, including the difficulty of tracking performance measures, difficulty in accessing information and loss of information. In addition to this, there is no control of real consumables, causing lower levels of productivity, since it is recurrent to stop the test phase of the prototype due to lack of raw materials.

In order to solve these problems, a proposal was made to implement an IT system (or digital tool, as it will be called) responsible for the management of information about the prototype and for the warehouse management. The aim of the study carried out in the Innovation Department was then to determine the tasks, jobs, and responsibilities of the actors in the test phase, to show the organizational changes in the implementation of the proposed solution, through the use of BPMN, and to develop the proposed solution, involving digitalization transformation.

3.3 AS-IS Process Analysis, Identification of Improvements and Design of the TO-BE Process

Given the limited space, in this paper only the BPMN diagrams related to the test phase will be described and graphically represented.

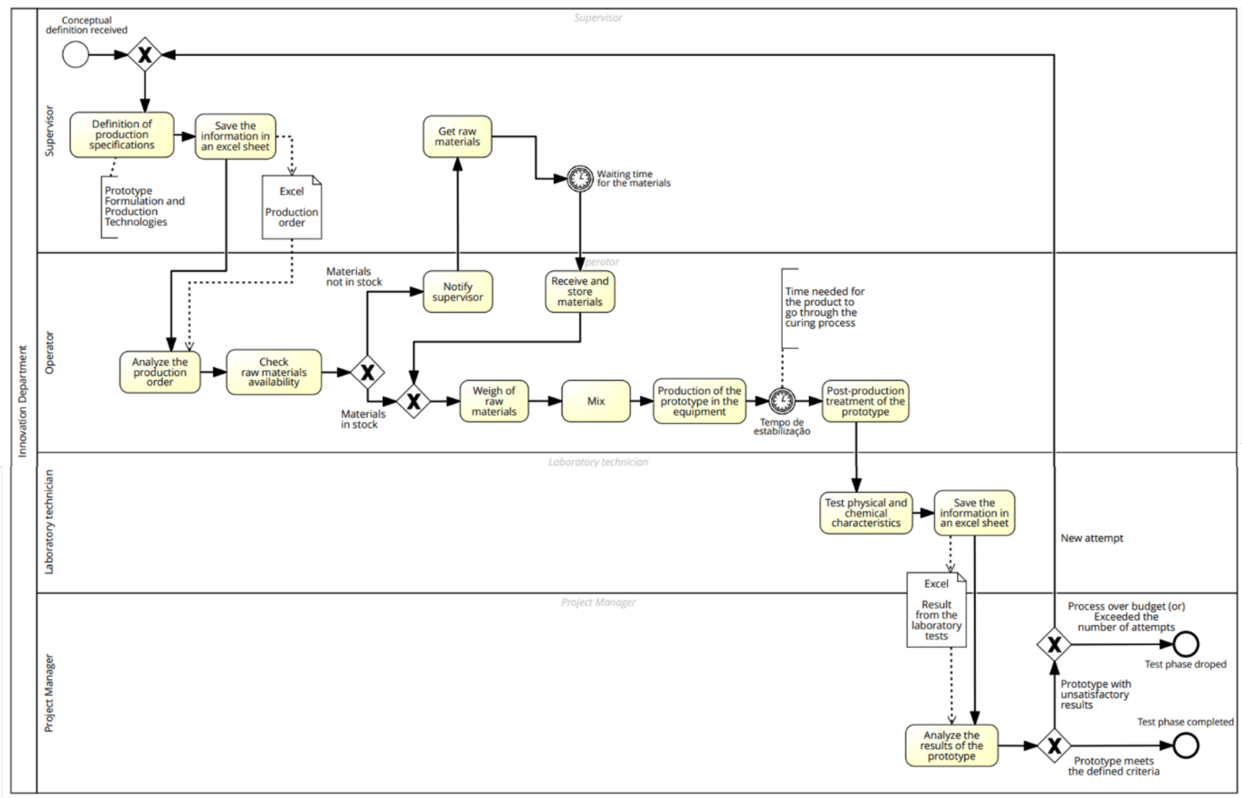

Figure 5 - AS-IS Test Phase

As shown in Figure 5, the test phase initiates when the conceptual definition (which is the previous phase of the macro process) is completed. This stage of the innovation funnel is responsible for the actual development of the new product and it develops in a loop, until the desired results for the new product are reached or until the process exceeds the maximum number of attempts or the budget. The test phase involves several tasks, from the development of prototype formulations to be produced, to the test and analysis of its physical and chemical characteristics. During the analysis of the tasks performed during this stage, the causes of the main problems were identified: (i) existence of manual records (high paper traffic); (ii) decentralization and fragmentation of information; (iii) low level of real-time information management; and (iv) no system to control consumables.

One of the most relevant aspects that is leading to these problems is the still very manual execution of some processes. First of all, there is no specific database to store the two distinct data objects – production orders and results of physical and chemical tests. In addition to that, these documents are created by different players - supervisor and laboratory technician –, promoting the decentralization of information. Because of that, if future problems arise regarding the prototype or if it becomes necessary to check the project information, it can be difficult to search for or find the information again.

Regarding the last cause identified, the lack of a system to control consumables, its consequences are also vast and widely known, such as the delay in delivering the product to the customer (be it internal or external), poor service, production stoppage or expenses increase.

At this point, in the methodology followed in this study, (re)design of the process is the next phase to be put in practice. As show in Figure 3, this phase requires the proposal of a new strategy through reengineering or design of a TO-BE process. Thus, Figure 6 shows the TO-BE process.

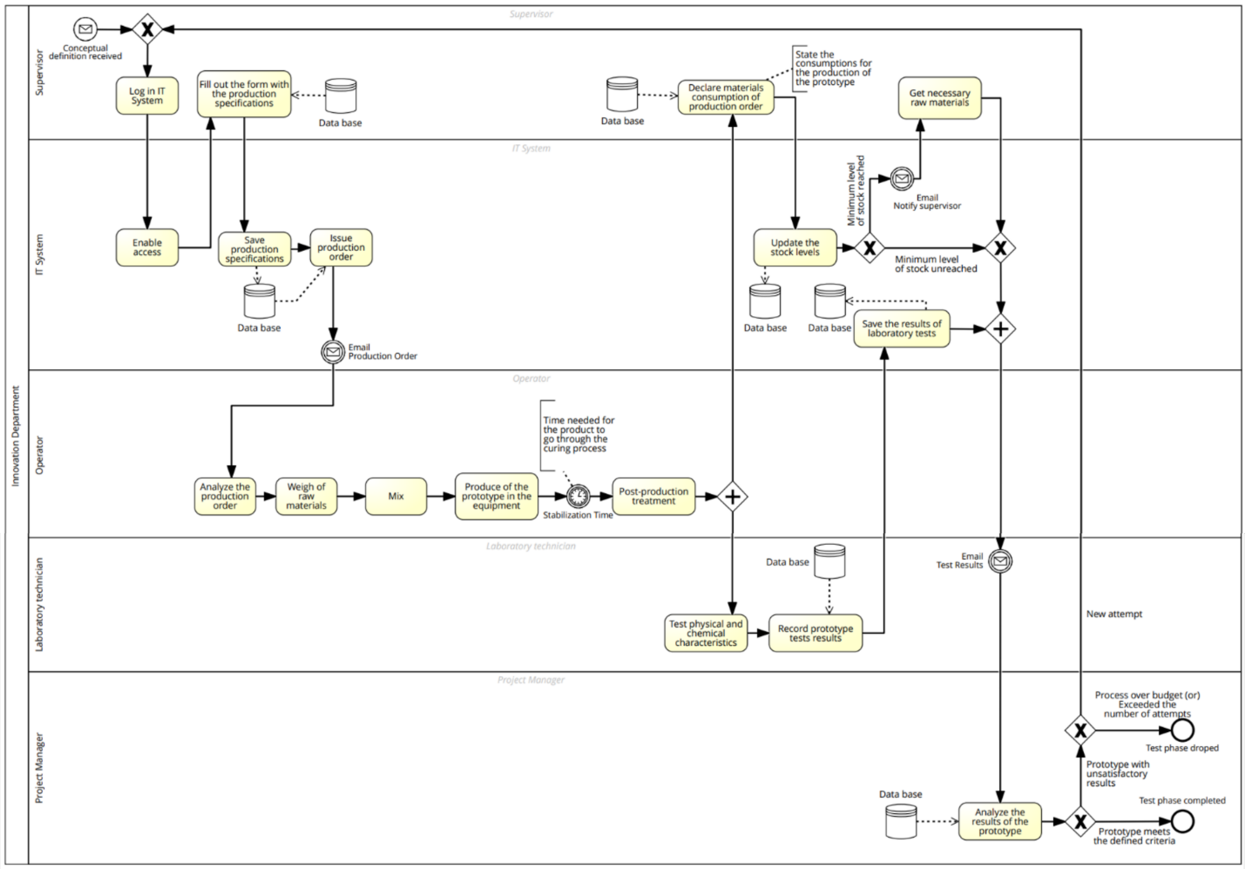

Figure 6 – TO-BE Test Phase

The main differences between the TO-BE process and the AS-IS one, focus on the implementation of an IT system. The system's implementation intends to link unstructured production documents and to create a digital and accessible structure that allows a proper information management, through centralization and availability of data in real time. The development of the proposed solution, involving digital transformation, is presented in the next section.

3.4 Development and Implementation of the Digital Tool

The database modeling of the IT system was carried out in UML (Unified Modeling Language), with the objective of representing the tool's functionalities, the collected data and some of the main procedures. During these phase, two distinct diagrams were developed: the class diagram (Figure 7), considered to be the best option in terms of functional data structure; the use-case diagram (Figure 8), especially useful in identifying functionalities accessible to each actor. All the features and functionalities of the system were delineated together with the stakeholders and the different types of actors that interact with the system. The functionalities to which each would have access were defined, represented in the diagrams and are described in detail below.

Considering the use-case diagram shown in Figure 8, there are four types of actors (hereafter referred to as users) that interact with the system or the system with them. As represented, the innovation user must be able to view the list of materials in stock, associate them with a location, declare their entry into the system, declare production and see the history of production declarations. When declaring production, two notifications are immediately sent to the logistics user and to the supervisor, and the system automatically updates the available stock levels. If the minimum stock levels are reached, the system issues a notification and sends it to the supervisor, as represented in the TO-BE process design. Additionally, the innovation user must be able to view, register and edit information about the prototypes, being presented with the possibility of attaching files about it. The same functionalities are available for recording project information. The relationship between the two registers is visible in the analysis of the class diagram (Figure 7): whenever a prototype is registered, it is associated with a project. In other words, a prototype refers to one and only one project and a project can have several prototypes. Furthermore, the innovation user must be able to see the performance indicators and register the existence of an error in the application.

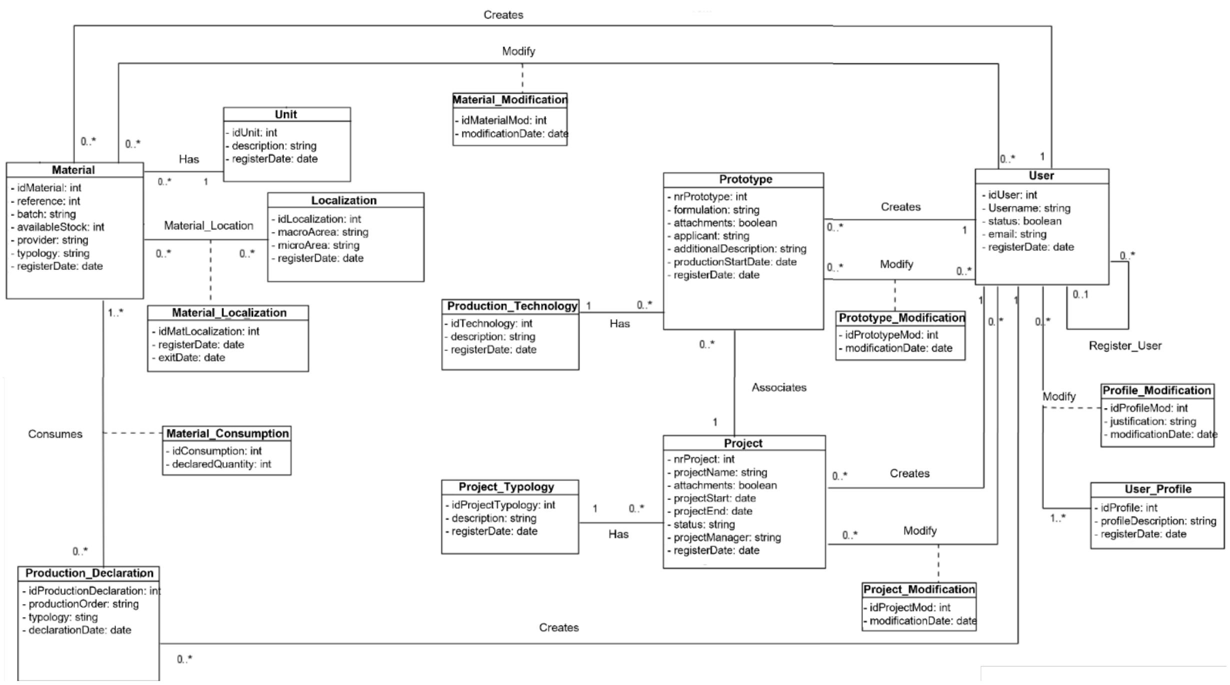

Figure 7 – Class Diagram

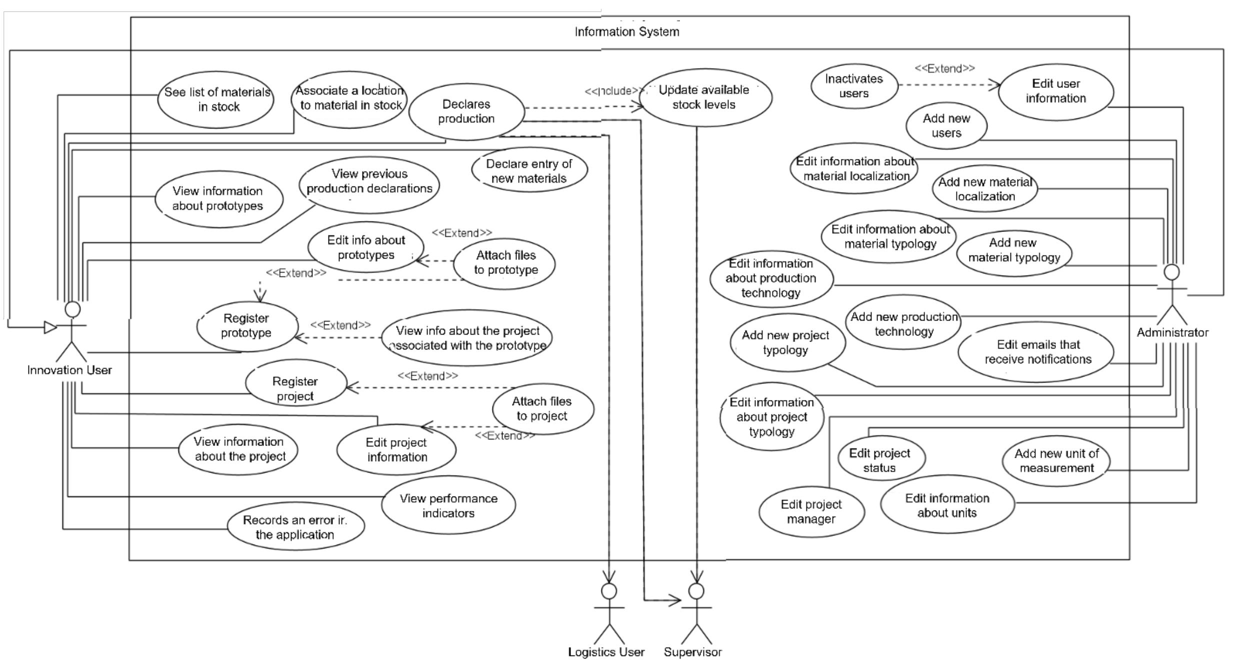

Figure 8 – Use-cases diagram

All use-cases mentioned above must be accessible to the administrator. In addition to these use-cases, the administrator must be able to register and edit a series of information, such as production technologies or material's typology.

The actors represented in the lower corner of Figure 8, the planning user and supervisor, are passive actors who do not initiate any use-case but participate in the system as they receive different types of automatically generated notifications.

For the development of the digital tool, Power Apps was chosen as the best suitable platform. It is a low-code software that works completely online, taking advantage of IoT technology to provide the latest information, anytime and to any user with access to the application. Despite being low-code, Power Apps allows the use of other programming languages to its users and, for the development of a more complex view, the html language was used.

By itself, Power Apps does not have the ability to store data, so it is necessary to choose a location where to store the data that is collected, viewed, and edited in Power Apps. In this study, the SharePoint was chosen as the platform to use. In the application (our digital tool), information is entered and edited in forms and viewed in galleries, within Power Apps. When a form is saved, an automatic flow is generated that sends the information to SharePoint. In practice, one more line is added to the table where the data is stored. This way, the user does not need to access SharePoint to view information from the tables as Power Apps has been programmed to centrally have the ability to collect, edit and make the information available.

In addition to SharePoint, there are other software to support the developed application. In particular, Outlook, for automatic notifications sent by the system, via e-mail, and Power BI, which is used to process data stored in SharePoint and which is included in Power Apps screen where users can access the dashboards. The calculation of indicators was only possible because the data structure of the information was completely different from what the organization had previously. Since these data are permanently online, it was possible to schedule an automatic update of the data to take place twice a day, keeping the dashboards with the most recent information.

In order to facilitate the analysis and understanding of the relationships between software and respective information flows, the scheme presented in Figure 9 was elaborated.

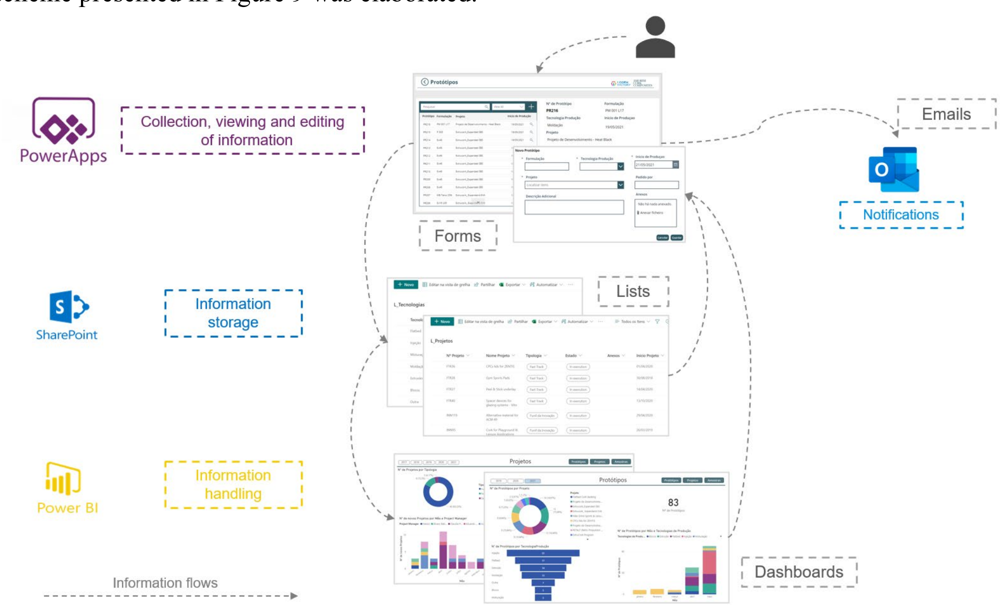

Figure 9 - Relation between the software used

In addition to the features represented in the TO-BE process, the digital tool developed has the ability to generate sequential codes and identifiers of the records created, whether prototypes, projects or materials, which enables their continuous identification. In particular, for prototypes, this sequential code is automatically printed on a label and pasted onto the prototype, which is then stored in the company. In this way, it is guaranteed that there is a continuous flow of information between what exists physically and virtually. More than that, it reduces the retention of high

information in the collaborators, since the prototypes are now identified and it is not only the collaborators who were involved in the production of a prototype that have the knowledge about it.
Next, the front-end of the developed application is presented. Until reaching the final version presented here, several tests were needed to verify the data flows and the correct connection between the different platforms. For confidentiality reasons, all figures will have certain hidden information, referring to specific data of the company where the study was carried out. The images presented in Figure 10 exemplify the front-end of the application. Due to space limitations, only four screens are represented.

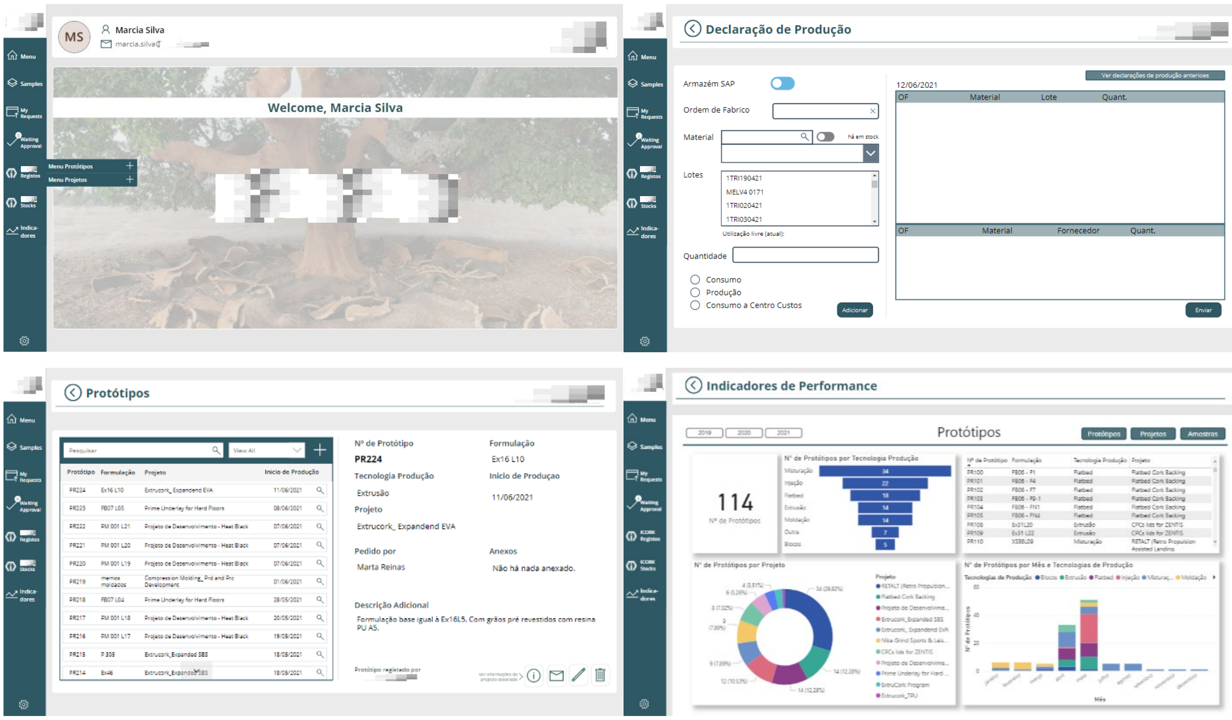

Figure 10 –Front-end of the application: examples of some user-interfaces

As it is visible in the images, when entering the system, the user will have access to an initial screen where he can activate several buttons in a side menu and navigate to the different screens, such as the prototype and project registration, the production declaration or the analysis of KPI's.

The digital tool, developed in the form of a web application in Power Apps, is very user-friendly. A training session for users of the application was enough for them to understand the full range of features available and the feedback was very positive. From the perspective of end users, the main advantages arising were the easiness in the traceability of prototypes and materials and the possibility of monitoring new performance indicators, which were previously non-existent.

In order to convey the essential ideas to each type of user, different training sessions were held. Furthermore, in order to promote organizational knowledge, a user manual was created and shared with stakeholders.

Additionally, in order to promote rapid data recording, a computer station was installed in the company, with a computer and a label printer. Thus, it is not necessary for the user to go to his desk, which is far from the working area, so that he can access all the system's functionalities. The placement of the computer station was essential to ensure that all operators have access to the application and that the label printer was located in a central area, available to all that needed it.

Nowadays, the developed application is being used in all its functionalities and has hundreds of records already processed. Due to the countless possibilities that can be developed within the application, there is an environment of continuous improvement that has been developed and, regularly, new ideas and features are generated, discussed and, if feasible, developed and put into practice.

4. Conclusion

This paper has presented a conceptual framework on business process management that culminated in the development and implementation of a digital tool to support the organization's transition from a traditional to a digital mode of operation.

The study focused on the problem caused by the vast amount of data stored in various documents without any specific organization or easy access. The proposed solution has the capacity of analyzing data and increases the amount of available information. It was developed in Power Apps, a low-code Microsoft software, and involved the use of other support software, such as SharePoint, Power BI and Outlook.

The use of the UML notation was essential for the development of the system, helping to present the tool specification from different functional points of view. Complementing the UML notation with the BPMN notation, it was also possible to map different information flows, which contain the identification of the actors involved in the process, their responsibilities and, in certain cases, the different steps to be followed, which can serve to ensure the sustainability of the tool.

During the development of the project, BPM was a critical tool since it facilitated the understanding of the system and, therefore, leveraged a successful digital transformation.

There are several positive results arising from the implementation of this digital tool, among which the improvement of information management, which is now centralized and formally structured, the creation of new key performance indicators (KPIs) and the increase in employees' satisfaction. The centralization of data that was previously recorded in different places and in different formats allowed to improve, not only access to information, but also its quality, the crossing of data and the speed of communication between different actors. Analyzing the consequences of the implementation of the information system in a broader scope, it is clear that the correct use of information systems is essential for an organization to remain competitive, efficient and in continuous improvement of its processes.
As future work, it would be interesting to develop the application in a mobile phone format and to add new features with the aim of continuing to facilitate the access to and the understanding of quality and pertinent information by users.

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Leonor Teixeira graduated in Industrial Engineering and Management, received a MSc. degree in Information Management, and a PhD in Industrial Management (Information Systems area), in 2008, from the University of Aveiro, Portugal. She is currently an Associate Professor of the Department of Economics, Management, Industrial Engineering and Tourism (DEGEIT) at the University of Aveiro. She is also a researcher (Integrated Member) at the

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