



28th International Scientific Conference
Strategic Management
 and Decision Support Systems
 in Strategic Management
SM2023

Subotica (Serbia), 18-19 May, 2023

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QUALITY MANAGEMENT AND DIGITAL TRANSFORMATION IN A PORTUGUESE HEI: A PROCESS MANAGEMENT APPROACH

Abstract: Over the years, Higher Education Institutions (HEI) have been changing the way they observe and approach quality and the management of their teaching, research, or knowledge transfer activities. There are several guidelines regarding quality management in higher education. In Portugal, besides the framework proposed by the National Agency (A3ES), HEI use other standards, such as ISO 9001 or the EFQM excellence model. A comparative analysis of these guidelines shows that they share principles, are based on a process management approach, and seek to improving the organization's performance. Regarding the process management approach, there is a perception that processes add value to the organization and facilitate the achievement of its strategic objectives. Additionally, the incorporation of technology in the processes makes them more agile and increase the organization's efficiency.

In this context, digital transformation is a reality that proposes a change in the way organizations operate, incorporating digital processes into their processes, thus making them more prepared to face market demands. In this paper we present a use-case of digital transformation in a HEI. Based on the Digital Kaizen methodology, this work focuses on a systematic approach to review quality processes in use at HEIs, modeling, digitalizing, and automating them in the form of business processes. As result, a well-defined method containing the steps for the transformation of processes is proposed, as well as a set of reference tools that support the digital transformation process.

Keywords: Digital transformation, quality management, process approach, higher education institution (HEI)

1. INTRODUCTION

Efficiency, agility and ability to responsiveness to change are key attributes for organizations. In a globalized world such as the one we have today, these attributes, also seen as challenges, dictate the ability of organizations to remain operational, responding to an increasingly demanding target audience. To better respond to these challenges and remain operational, organizations seek and develop mechanisms that allow them to systematically: understand what they do, how they do it, identify risks and opportunities, be in line with legislation, regulations and requirements market and define procedures and corrective actions to quickly respond to change. It is within this framework that organizations identify quality management systems (QMS) as an important tool to support their operation. A QMS is a set of policies, processes, procedures, and resources that an organization uses to ensure that its products or services meet or exceed customer requirements and expectations. The role of a QMS is to help an organization achieve consistent quality and customer satisfaction, as well as to continuously improve its processes and products (Sá, Amaral, Barreto, Carvalho, & Santos, 2015; Sá et al., 2020; Santos et al., 2019).

One of the most widely used and recognized standards for quality management systems globally is ISO 9001 - a standard for QMS developed by the International Organization for Standardization (ISO) (Sá et al., 2020). ISO 9001 certification is not mandatory, but many organizations choose to pursue certification to demonstrate their commitment to quality and gain a competitive advantage. The implementation of a QMS, based for example on ISO 9001, involves a set of steps (Santos, 2018). One of the steps is to develop a quality manual and procedures. That is, the creation of a manual that

outlines the organization quality policy and objectives, as well as the procedures that will be used to achieve them. This should include procedures for all relevant areas, such as management review, document control, internal audits, corrective and preventive actions, and customer complaints. This manual is in practice a document, supported by several other documents that allow the organization to operate in a common way among its departments. However, it happens that a QMS can become complex to maintain. This occurs for several reasons, such as, lack of resources, overcomplication in terms of processes or documentation, difficulty in keeping up with continuous or frequent changing requirements, lack of buy-in by staff or stakeholders or resistance to change. To address these issues, it is important for organizations to take a strategic approach to their QMS, focusing on simplicity, efficiency, and continuous improvement.

One area that aims to provide organizations with mechanisms that facilitate innovation and change is digital transformation. Digital transformation is a gradual process that, according to (Plekhanov, Franke, & Netland, 2022) includes four main phases. The first stage of digital transformation is digitization, and it involves digitizing existing processes and data. The goal of digitization is to improve efficiency and reduce costs by eliminating paper-based processes. The second stage of digital transformation is optimization, and it involves using data analytics and more advanced digital tools to optimize existing processes and operations. The third stage is transformation involves leveraging digital technologies to fundamentally change the way an organization operates. This may involve using cloud computing to scale operations globally, developing new business models based on digital platforms, and creating new products or services that are enabled by digital technologies. The fourth stage of digital transformation is innovation and involves disrupting existing markets and business models using digital technologies. This may involve creating new products or services that disrupt existing industries, using top technology to create new business models based on trust and transparency, or leveraging artificial intelligence to create new customer experiences.

The School of Management and Technology - Polytechnic of Porto is a Portuguese HEI that, since 2006, has a certified QMS, according to ISO 9001. The QMS follows a process-based approach, and the organizational processes are divided into three levels: management processes; realization/operational processes and support processes. The system is rooted in the organization and is seen as an asset by all. It turns out that the QMS is still in the first phase of the digital transformation process (digitization) and in this context an opportunity for improvement was identified, which consists of its evolution to the third phase of the digital transformation. This opportunity is leveraged by a funded project (Quality 4.0 - Digital Transformation in Quality Management Systems) and aims to improve the efficiency and agility of the QMS while allowing interoperability between systems and leveraging a more generalized use of procedures, i.e. extended to more HEI belonging to the Polytechnic of Porto universe.

In this paper we present a use-case of digital transformation in a HEI. Based on the Digital Kaizen methodology, a systematic approach to review quality processes, modeling, digitalizing, and automating them in the form of business processes is presented. The approach encompasses methodologies and tools for modeling and automating business processes that facilitate the digital transformation process and contribute to greater efficiency and agility of the organization. In this way, other organizations can become aware of the digital transformation process carried out, the methodology used, the technologies involved, facilitating critical analysis, and ultimately helping the transformation process of these organizations. Although the use-case is applied to an HEI, it should be noted that the adopted process is transversal to a wide variety of organizations.

The rest of the paper is organized as follows: section 2 presents the literature review; section 3 presents the proposed methodology to transform QMS processes; a use-case regarding the digital transformation of HEI processes is presented in section 4; section 5 concludes the paper.

2. LITERATURE REVIEW

In this section, a review of the literature is presented, focusing in a first phase on quality management systems (QMS), with a focus on higher education institutions (HEI), and in a second phase on the digitalization process of these systems.

2.1. Quality management systems: guidelines for HEI

Quality management in higher education is an important aspect to ensure that institutions are delivering high-quality education to their stakeholders (Basari, Altinay, Dagli, & Altinay, 2016; Girmanová, Šolc, Blaško, & Petrik, 2022; Myna, Yarka, Peleschshyn, & Bilushchak, 2016; Rosa, Sarrico, & Amaral, 2012). There are several guidelines and frameworks that institutions can use to implement quality management practices. Some of the commonly used in Portuguese Higher Education Institutions (HEI) are:

- Reference Framework for Internal Quality Assurance Systems in Portuguese Higher Education Institutions: This framework is proposed by the Agency for Assessment and Accreditation of Higher Education (A3ES, 2015). A3ES is a Portuguese Agency that evaluates and accredits higher education institutions and their programs. A3ES framework provides guidelines and criteria for quality assurance in higher education based on European and Standards Guidelines (ESG, 2015).

This framework is systematized around five vectors: policy for quality assurance; nuclear processes of the institutional mission (teaching and learning, research and development, inter-institutional and community collaboration, and internationalization); management of human resources and of the material resources and support services; management and publication of information; and periodic external review (A3ES, 2015).

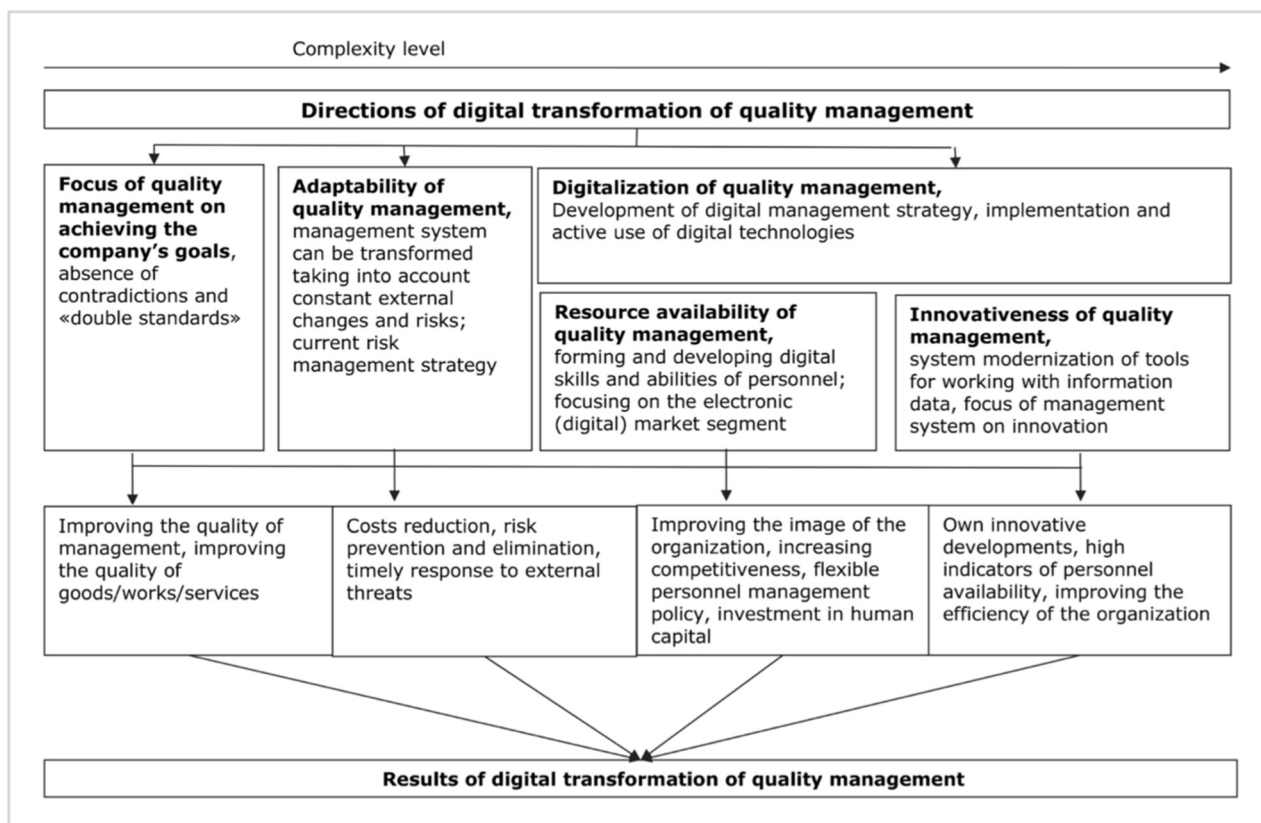
- ISO 9001: ISO 9001 is a QMS standard that can be applied to any organization, including higher education institutions. The standard provides a framework for institutions to establish, implement, and maintain a QMS that focuses on meeting customer requirements and enhancing customer satisfaction (ISO 9001, 2015). This standard outlines seven quality principles that serve as the foundation for the ISO 9001 standard. These principles are: customer focus - meeting customer requirements and to strive to exceed customer expectations; leadership - leaders should set a clear vision, establish goals and objectives, and create conditions in which people are engaged in achieving the organization's quality objectives; engagement of people – recognizing the importance of its people and their contributions, and providing training, education, and development opportunities to empower them; process approach: implementing a systematic approach to managing processes and resources to consistently achieve the organization's objectives; improvement: involves continuously improving the performance and effectiveness of the organization by identifying opportunities for improvement and implementing actions to address them; evidence-based decision making: decisions within the organization should be based on analysis and evaluation of data and information; and relationship management: relationships with suppliers, partners and other stakeholders should be established and maintained to ensure mutual benefit and value creation (ISO 9000, 2015)
- EFQM model (European Foundation for Quality Management): The EFQM model is a framework for organizational excellence that can be applied to higher education institutions. The model provides a holistic approach to quality management and focuses on three domains: direction (purpose, vision & strategy; organizational culture & leadership), execution (engaging stakeholders; creating sustainable value; and driving performance & transformation) and results (stakeholder perceptions; strategic & operational performance). The EFQM model is based on a connection between the purpose and strategy of an organization and how that connection is used to help it create sustainable value for its relevant stakeholders and deliver outstanding results (EFQM, 2020).

A comparative analysis of these guidelines and frameworks shows that they are based on a process management approach, as it enables HEI to achieve their objectives, monitor their performance, and adapt to emerging challenges (Da Silva, Vieira, & Da Silva, 2017). Additionally, HEI can ensure that it is delivering high-quality education and services to their students and other stakeholders.

2.2. Digital transformation in quality management systems

The literature on digital transformation and quality management systems is recent and usually states that digital transformation can impact quality management systems (Carvalho, Sampaio, Rebentisch, & Oehmen, 2020; Mayakova, 2019; Menshikova, Piunova, & Makhova, 2019).

Menshikova, Piunova, & Makhova (2019) found that there is a need to transform quality management systems in the digital economy. They suggest an integration of the quality management system into the general management system by establishing the digital platform in the organization, emphasizing the need for risk identification at all stages of system implementation. In the same line, the research carried out by Mayakova (2019) found that digital transformation of quality management can have positive effects on organizations. An integrated model of quality management in the context of digital expansion was designed, based on the process approach (Mayakova, 2019). Figure 1 presents the model that combines the key areas of quality management and digital transformation.



Picture 1:Quality management model in the context of total digitalization
Source: Mayakova, 2019

Other authors found that digital transformation of quality management systems can impact the quality management stakeholders (Manakhova, Levchenko, & Esina, 2021) and the tools and methods of quality management (Carvalho et al., 2020). Consequently, digital transformation can have a significant impact on quality management systems.

3. METHOD

By implementing a QMS, a HEI is working to meeting its quality standards and continuously improving its processes to provide a high-quality education to its students. By adopting digital transformation, HEI is seeking to improve its operations, enhance student experience, and stay competitive in the ever-changing education landscape. As it turns out, things come together, and so the innovation and digital transformation of the QMS contributes to the digital maturity of the HEI and consequently to its efficiency, effectiveness, quality, and agility.

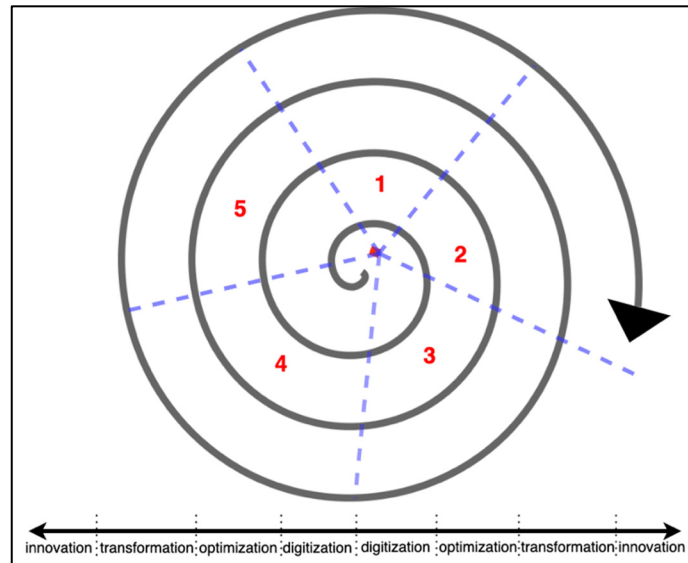
Change for the better and continuous improvement are the two key concepts of the Kaizen methodology (Imai, 1986). Such concepts are also fundamental to quality management and innovation and digital transformation. Table 1 provides a mapping between the digital transformation steps and the Kaizen methodology steps. From the combination of digital transformation and Kaizen methodology, arises the Digital Kaizen concept, that is being used by authors for the development of large-scale digital transformation projects (Dang-Pham, Hoang, Vo, & Kautz, 2020, 2022).

Table 1: Mapping between the digital transformation and the Kaizen methodology main steps

Steps	Digital Transformation	Kaizen Methodology
1	Understanding the current state	Identifying areas for improvement
	Identifying improvement goals	
2	Developing an action plan	Developing a plan for change
3	Implementing the changes	Implementing the changes
4	Monitoring and measuring progress	Measuring the results
5	Standardizing new processes	Standardizing the process
6	Sustainability and continuous improvement	Continuously improve

The systematic execution of the steps listed in Table 1 leads to the identification of improvements and consequently to actions towards its their implementation. When QMS and digital transformation or the digital Kaizen concept are combined, it becomes necessary to unfold the stages leading to a systematic phased approach. Picture 2 illustrates the

proposed systematic phased approach. The steps 1 to 5 correspond to the Kaizen Methodology steps presented in Table 1. Step 6 corresponds to the iterative cycle process. Improvements are applied at each iteration and if such improvements are part of the digital transformation, then the system will evolve towards an upper stage of digitalization (digitization – optimization – transformation – innovation).



Picture 2: Combining digital Kaizen and digital transformation – Systematic Phased Approach
Source: Authors

The QMS that the School of Management and Technology - Polytechnic of Porto has is currently in stage 1 (digitization). The work carried out under the Quality 4.0 - Digital Transformation in Quality Management Systems project focuses on the digital transformation of the QMS, raising it to stage 3 (transformation). To achieve it, the six steps of the Kaizen methodology will be applied.

3.1. Combining Quality Management and Business Process Management

It is often mistakenly believed that digital transformation is solely focused on implementing new technology and business strategies. However, the truth is that the most essential aspect of digital transformation is the transformation of organizational culture. Since the scope of the project is the evolution of the QMS system, moving from phase 1 of the digital transformation to phase 3, we start from the assumption that the organization culture issues are addressed, and the focus now is the transformation stage. This stage involves using technology to fundamentally change how a business operates and interacts with customers. This may involve introducing new products or services, adopting new business models, or creating entirely new customer experiences.

The revised ISO 9001 promotes Business Process Management (BPM) as a technique that adds value to the QMS itself and improves the final service or product. BPM is an organizational approach that focuses on recording and improving business processes to help people in an organization work more efficiently. This is achieved by mapping, recording, and documenting an organization's current end-to-end process. Documenting processes in a process map allows process owners to identify where inefficiencies are and gaps to improve. This helps the organization to base its decisions on evidence and data, while making the necessary changes to each process to eliminate waste, reduce costs and eventually improve efficiency. BPM automation comes from Workflow Management (Workflow Automation Tool) that connects the people who execute the processes with a digital system and the right tools for a more efficient way. BPM is described by several authors (Dumas, La Rosa, Mendling, & Reijers, 2013; Rosemann & vom Brocke, 2015) and used in numerous projects. Business Process Model and Notation (BPMN) is a graphical notation used to model business processes. It provides a standardized way for businesses to visualize and communicate their processes, making it easier to understand and analyze them. It uses a set of symbols and graphical elements to represent the various components of a business process. BPMN is widely used in business process management (BPM) and is supported by most BPM software tools. It has become the standard for modeling business processes and is used by organizations of all sizes and industries. There are evolutions on BPMN that add important features. One of the evolutions is called intelligent Business Process Model and Notation (iBPMN). iBPMN adds more intelligence and automation capabilities to the notation. It includes additional symbols and elements that can be used to model more complex and dynamic business processes, such as those involving artificial intelligence (AI), machine learning, and decision-making algorithms.

This project starts from a quality management system in stage 1 of the digital transformation process (digitization), applies the steps identified in the Kaizen methodology to, through modeling and automation tools (iBPMN), transform these processes making them more efficient and agile.

4. DIGITAL TRANSFORMATION OF QMS PROCEDURES

In this section we present the digital transformation process of the quality system procedures in use at the School of Management and Technology - Polytechnic of Porto.

4.1. Applying the Kaizen Methodology

The project started with the application of the Kaizen methodology. In this way, the procedures to be transformed were identified, prioritizing them according to the impact they represent on the efficiency of the process to which they belong. Once the procedures were identified, an attempt was made to model the new business process using iBPMN modeling tools. The main interlocutors of the procedure were involved in the modeling, thus allowing the assessment of the true role of each interlocutor in the procedure, as well as the flow of information to be considered in the business process. Once the business process was validated, the next phase was its implementation using an iBPMN system. The choice of the iBPMN system to use fell on the Camunda tool (Zuhaira & Ahmad, 2021). The choice was based on a set of requirements, among which stands out the adoption of an open-source solution and a solution that, in addition to allowing modeling, facilitates interoperability with existing systems as well as the automation of the business processes. Modeling and automation through an iBPMN solution also facilitates the collection of process-related metrics. In the workflow engine, it is possible to obtain data at any moment, such as the status of each process, the number of processes running for a given user or the average time between processes or process tasks. The collection of these data contributes to the measurement of the results obtained with the modeling of the process. A well-defined process, capable of responding to the needs of the business and audited at every moment, contributes to its adoption, becoming a standard in the sense that everyone performs operations in a similar way, leading to greater consistency thus reducing the likelihood of errors occurring. The fact that the procedure is graphically modeled and easily understood by the organization facilitates the continuously improve needs, thus reducing obstacles to its change whenever justified.

4.2. Modeling and Automation Requirements

For the modeling and automation of business processes, the following list of requirements were considered:

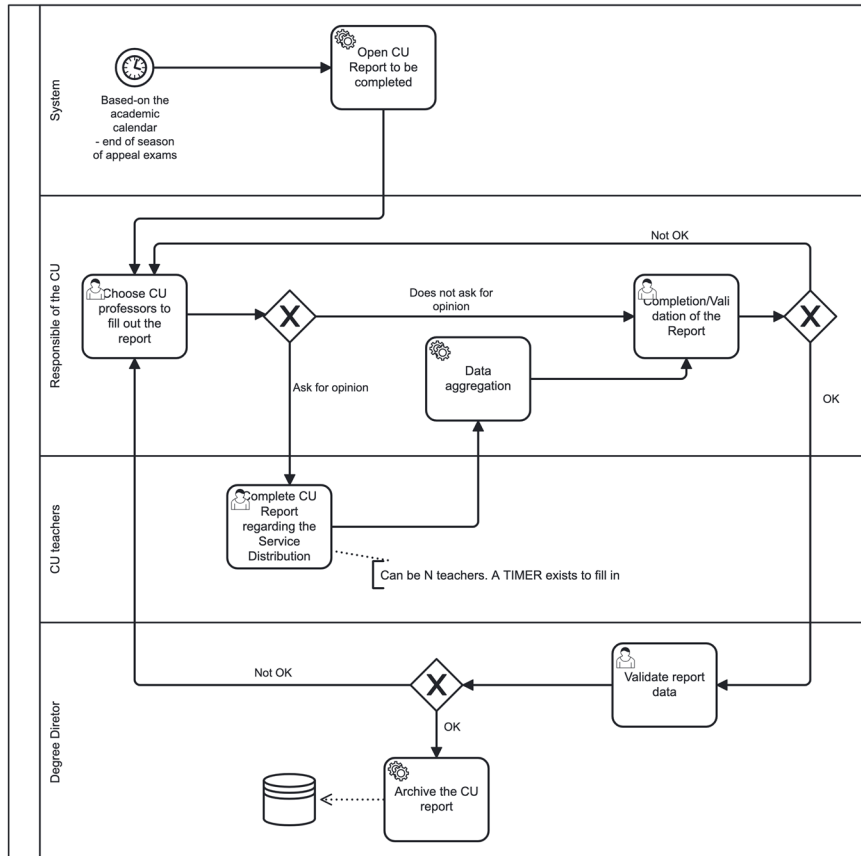
1. Agility: processes can be completed more quickly, not only due to better orientation of pending work, but also due to faster decision-making and the potential reduction in the number of human errors;
2. Ease of change: the processes will not be static and will be able to evolve quickly, accompanying the needs of an activity that also evolves dynamically;
3. Productivity: the availability of action/decision support mechanisms allows for a clear increase in productivity accompanied by an increase in the quality of the work carried out;
4. Risk reduction: the support tools, in concert with automatic validation mechanisms, allow the proactive detection of possible errors, reducing the risk of their occurrence;
5. Compliance and transparency: the possibility of analysis and detailed review of the activity developed, associated with the definition of automatic validation rules, promotes compliance of the work with procedural rules, as well as transparency about the activity. This aspect can be particularly important for departments and managers, who will be able to have detailed access to activity details and receive automatic notifications in cases that are identified as subject to review;
6. Less human dependence on the execution of processes: aspects such as automated document production make it less dependent on specific people, allowing that, in cases such as unavailability due to holidays, illness, or others, the activity can continue without interruptions;
7. Repeatability: in terms of procedural execution, the system will promote the fulfillment of similar processes under similar conditions. This aspect directly results in the promotion of the homogenization of the level of quality in the execution of processes;
8. Reliability: the permanent updating of information from dynamic, reliable and detailed data sources, as well as the dynamic application of rules for inferring new information, not just from static data, but applying real intelligence in the combined analysis of data from different sources, promotes the reliability of decision-making processes;
9. Dematerialization: the adopted approach will definitively promote spontaneous document dematerialization, as well as the implementation of principles such as Only Once (Mamrot & Rzyszczyk, 2021) and digital interoperability.

These requirements also weighed in the choice of Camunda, as the modeling and automation tool.

4.3. Use-Case: Transforming Quality Processes using iBPMN

This section presents the transformation of a procedure related to filling in the curricular unit report (CU report). In the pre-digital transformation QMS version, the CU report is opened at the beginning of the school year. The person in charge of the CU must remember, according to the defined procedure, to complete the report as soon as the academic semester ends. If the person in charge of the UC wants to collect information from the teaching team about the functioning of the CU, he will have to do it outside the system (e.g., by email) and consolidate all the inputs received.

This procedure, which is simple to describe and carry out, was analyzed and aspects to be improved were quickly found. One of the aspects has to do with the timing of the opening of the report for completion, another has to do with the possibility of collecting information about the functioning of the CU from the teaching team by defining a timer for data collection. The information from the various teachers is aggregated in the report and after being validated, it is made available to the person in charge of the CU for appreciation and archiving. The result of the process modeling is shown in Picture 3.



Picture 3: iBPMN of the curricular unit report process
Source: Authors

One of the advantages of modeling using iBPMN is that the flowchart shown in Picture 3 is loaded and executed into a process execution engine. A manual or service action is attached to each task thus allowing human-to-machine (synchronously) or machine-to-machine (synchronously or asynchronously) interaction. Another great advantage with process modeling using iBPMN and the Camunda process engine is that each intervening party knows at every moment the task they must perform, and it is possible to visualize the process at every moment and obtain its status all the time. With the previous system, this information did not exist, thus emphasizing the advantages of digital transformation, namely efficiency, agility and ability to respond to change.

5. CONCLUSIONS

Digital transformation is seen as a necessity for organizations to face the need for change and continuous improvement. Usually, it is associated with the industry and the introduction of technology in it, thus making it more modern and operational in a global world. It turns out, however, that innovation and digital transformation has a much broader application. A HEI, for example, has numerous processes, procedures and documents that support its activity. In the specific case of the School of Management and Technology - Polytechnic of Porto, a QMS in line with ISO 9001 was

adopted and used as support for the activity carried out. It is a mature system regarding the processes, procedures, and adoption, but it lacks for transformation to make it more agile and efficient. It is from this need that the Quality 4.0 project was proposed and approved.

Throughout this paper, the role of digital transformation and the stages inherent to it were highlighted. The QMS is in stage 1 - digitization - that is, it consists of a set of documents in digital format that are governed by procedures. Its transformation into business processes, modeled through iBPMN solutions, allowed its automation and integrated execution in a process engine, thus contributing to an easy redesign of procedures and to a better monitoring of the same by the various actors in the process. With systematic phases approach, the procedures passed from stage 1 of digital transformation to stage 3. To date, we have several processes modeled and, recognizing the advantages of the digital transformation, this paper contributes with a methodology and a set of technologies to support a smooth and value-added digital transformation of a QMS. Although the work presented is focused on an HEI, it should be noted that the approach is generic enough to be successfully applied in other organizations.

FUNDING

The work of the authors João Paulo Magalhães and Vanda Lima is supported by EU funds, through the AMA – Administrative Modernization Agency under the project POCI-05-5762-FSE-000182.

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