Information Technology Service Management to streamline decision making in UTAD – An e-governance case study

António Rio-Costa[1], José Bessa[1], Alberto Vasconcelos1, Elsa Justino[1,2]

[1] Universidade de Trás-os-Montes e Alto Douro UTAD, Quinta de Prados, 5001-801 Vila Real, Portugal, acosta@utad.pt; jmiguelbessa16@gmail.com; albertov@utad.pt; ejustino@utad.pt

[2] CAPP-Centro de Administração e Políticas Públicas da Universidade de Lisboa, Portugal.

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1. ABSTRACT

The application of the concept of e-Governance has been demonstrated in several countries, Portugal included, and one of the areas that has manifested greater interest in its application to Education, with a major focus for HEIs. This application is possible to validate in this article through the case study of the University of Trás-os-Montes and Alto Douro (UTAD). Using an Enterprise Architecture (EA) to manage its e-Governance component, this institution has identified the need to invest in Information Technology Service Management (ITSM) to streamline decision making in IT infrastructure management and user support. Higher education institutions (HEIs) make big efforts to provide more efficient services, to increase the means of communication between the parties and to manage in a more expeditious way the business processes and the information that they originate, aiming to obtain satisfaction and quality of the services provided. In order to operationalize these efforts, to dynamize and accelerate in a secure and permanent way the access and the delivery of information, we've focused on resources supported by the Information Systems/Information and Communication Technologies (IS/ICT) binomial, which refers to the application of the e-Governance concept. Given the complexity of managing e-Governance, institutions often rely on Business Process Management (BPM) frameworks, and Enterprise Architectures (EA).

Keywords: e-Governance, quality assurance, knowledge management, HEI, UTAD, Portuguese case study.

2. Introduction

The constant changes of the environments in which the organizations are inserted demands the need to possess Knowledge and Intelligence in all their areas of action, becoming information a nuclear component for organizations of any sector of the society. It is very important that organizations consider information as a resource, always assuming that it needs to be managed [1]. Due to the large amount of data that organizations have stored, it is important to use systems that enable to identify, from that

data, trends and activity patterns, in order to generate knowledge to support employees with management responsibilities to decision making processes [2] .

Given the value of information for modern organizations, it should be treated and managed as a resource similar to what happens to labour and raw materials, since it is one of the most important resources (perhaps the most important) and valuable to achieve their goals and success [3]. In this scenario of constant mutability in which the organizations are inserted and, given the concerns to make the information management processes more efficient, the IS supported by the ICTs (merging them in the IS/ICT binomial) allows to obtain and make available the information in a way faster and more reliable, and the use of its processing capabilities on this resources has made it possible to obtain organizational knowledge, which is indispensable for meeting the demands of markets and society [4].

The technological component in organizations has added importance to information and knowledge. The two decades have significantly evolved the way to produce material and immaterial goods, and to serve as a foundation for the production and valorisation of financial capital (converted in information) and flexibilization of information production, as well as its viability, distribution (using communication networks), commercialization and consumption [5].

Thus, IS/IT, Information and Knowledge are increasingly ingrained in society, in people's daily lives, in socialization processes and constitute some of the most important assets for the success of organizations [6], as in the case of other resources, it is essential to audit compliance with quality, control and safety requirements [7], in addition to their consistent and constant evolution/updating. This context does not only apply to the panorama of private sector institutions, but also to the organizations that belong to the domain of public administration, which motivated the emergence of the concept of e-Governance [8].

This concept has been recognized as fundamental for the reform and modernization of governmental institutions and is closely related to the use of ICT and IS (many of them Web-based), to ensure and streamline the handling of processes and information management, between institutions and service users, in a faster, safer and efficient way[9]. Due to the complexity of e-Governance management, standards, methodologies and frameworks (e.g., Six Sigma), enterprise architectures (EA) and business processes (BPM) are often used in order to more efficiently and expeditiously determine the needs in this area [10].

Within the public sector where it is applied, the HEIs have undergone a great evolution in e-Governance , being this situation transversal to the Portuguese Higher Education Institutions (presenting UTAD as a paradigmatic case) and, taking into account its applicability in the context of the current work, it sought to explore the impact and importance of the concept of e-Governance in these institutions. This was explored through a case study based on the work developed [11], which proposes a model of EA for the management of this components.

The present article is organized in three sections: section 1 presents the framework of the article, followed in section 2 by the conceptual approach of the themes that support the developed work. Section 3 describes the case study, the investment made by institution in the area of e-Governance, what are their needs and motivations and how this concept has acquired importance, in the management perspective of its processes and infrastructures, quality assurance of services (through obtaining certifications such as ISO/IEC) and obtaining satisfaction from its users. The case study also presents a version of e-Governance oriented to the services offered to the users (G2C - Government to

Citizens). The article ends with the final considerations drawn from the presented work and the perspectives of future work.

3. Conceptual approach in the context of Higher Education Institutions

3.1. Presence in the Information Society

The modern world has been growing in knowledge but also in complexity and speed, constituting itself as a vast interactive system where the search for a balance between economic, technological and social forces generates turbulence to the environment of organizations [4], with Information and knowledge to become central elements in the development of all human activity, which makes contemporary society often called the Information and Knowledge Society [12, 2].

In this new social paradigm, the education sector assumes a preponderant role due to its influence on the social, political and economic development of society in general and of other sectors in particular [13]. Regarding the constituent elements of this sector, the case of HEIs (in specific public ones) is the one that contextualizes the scope of the work presented in this article. The HEIs are positioned as entities at the forefront of knowledge and wisdom, constituting an essential part of the current economy of the regions where they are inserted and of the countries with which they interact [14].

In Portugal, HEIs focus its education on high-level qualification by stimulating the production and dissemination of information and knowledge, as well as the cultural, artistic, technological and scientific training of its students. The performance of its activities is based on four major dimensions: Education, Research, Innovation and Extension, which can be complemented by the dimensions of Culture and Science [15,16].

These institutions are daily exposed to rapid and successive economic, political, social, technological and educational changes at both national and international levels (e.g., partnerships between institutions and relations with foreign entities). In addition to the pressures and changes to which HEIs are subject, their stakeholders expect them to respond in a timely manner to these adversities, although there is a decrease in government, business and private sector support, which contrasts with growing regulatory requirements which fall on the transparency and accountability of these institutions [17, 18].

The development of HEIs and their capacity to respond to the pressures and changes previously mentioned depend not only on material, economic and financial resources but also on intangible assets such as information and knowledge to meet the challenges of organizations such as competitiveness, innovation, modernization/evolution, productivity, performance, quality, insertion in international markets, globalization, virtuality, ubiquity and urbanity [5,19].

Given the importance of these intangible resources, there is a need to manage their availability and productive action, using the Information and Communication Technologies (ICT) [20]. ICT enables the information to be obtained and made available in a faster, timely and reliable manner, and the use of its processing capabilities on this resource has made possible to obtain organizational knowledge, which is indispensable for meeting the demands of markets and society [21].

The turbulence of today's society, based on ICT, fosters in organizations a growing possibility of access to new markets, increased competition, loss of tangibility of products and services, ease of access to information, virtualization of markets and organizations, in the increase of economic speed, among others [22].

The ability to manage and create information is at the core of differentiating organizations and creating competitive advantages. Therefore, by the use of ICT combined with the intervention of information systems (IS) [23], causes an impact on the management of organizations through dynamism of its operation, boosting its development as active socioeconomic agents. The importance of the IS today, comes from the fact that they are multidisciplinary, since they can intervene in different activities of an organization, at the different Strategic, Tactical, Technical and Operational levels [1].
The integration of the IS/ICT binomial in these institutions is at the top of the educational reform priorities at the level of management, since the use of this technology is seen as an indispensable tool enabling these institutions to participate fully in the information and knowledge society [24]. This technological component has made possible to change the way these institutions carry out their main activities, sometimes breaking down the geographical barriers of their campuses, so that they can meet new challenges and reach new target groups [11].
The use of ICT has led to the development of ISs, which over the last few years have come to the IES in an intensive way, to be applied in a wide range of activities, from management to strategic level, to operational management, learner activities, teaching, academic community and resources that enable the effective and efficient performance of their daily activities [6, 25].

2.2 The adoption of business processes and business architectures for the management of e-Governance

HEIs have always played a key-role in society, but are gradually being assumed as the centre of knowledge-based economies [26]. At the level of management, HEIs are assigning more importance to the use of IS because of the advantages they bring mainly in performance and acquisition of competitive advantages [27], in an environment clouded by the intensive growth of information from their operations, being these systems at the top of their investment and research projects [28].
The growth of IS/ICT in HEIs is very evident, and its use is translated into the provision of services to students in a new and creative way, such as the provision of educational contents and improved access to services associated with academic life management [29]. These systems have also come to automate processes, allowing better performance than when performed manually, reducing the number of human resources involved to accomplish tasks, increasing the satisfaction of both HEIs and the academic community they serve [30].
This use of the IS/ICT binomial in public HEIs, both for the management of internal processes and for the provision of services to its community, refers us to the e-Governance concept. In its genesis, this concept translates into the use, by public sector bodies (including public HEIs), of web-based technology and services, to make possible to dynamize and accelerate in a secure and permanent way the access and the provision of information, as well as the use of services by national or international citizens, business partners, officials or other organizations (governmental or private) [31, 32].
The application of e-Governance in this type of institution can allow the construction of new forms of interaction and relationship with its academic community (from students, teachers, non-teachers, employees, partner entities, etc.) established until then [8]. On the other hand, the HEIs now have the means to achieve greater robustness, automation, simplification and transparency in their operations, core processes and decision making, to establish more efficient, optimized and reliable communication channels, being able to provide information and services in a more expeditious way, with lower cost, greater

reliability, greater security and integrity, in a permanent way and with a radius of action that affects larger groups of entities and individuals [33,34].
In view of the value of e-Governance in fulfilling the strategy, the mission, the objectives and scope of sustainability and certifications attesting to the quality of the services provided, public HEIs have been increasingly involved in their development, and throughout the countries, as in Tunisia [28], Tanzania [35], Portugal [11], the Republic of Moldova, Sweden [36] and India [9].
In order for them to derive benefits from the IS/ICT binomial, public HEIs need to make good management and good control of their ICT resources and infrastructures, and at the same time, it is imperative that IS reflect their processes efficiently (e.g., scientific repository, library service), teaching (e.g., e-Learning and Moodle) and administration (e.g., academic services, human resources, quality management, heritage and financial resources) [37].
In order for the e-Governance component of these institutions to be successful and able to reach their full potential, while guaranteeing quality standards, it requires that a strategy for planning and managing the IS/ICT binomial be drawn up, being the BPM as an interesting approach, since it contemplates the analysis, design, implementation and optimization of business processes [38, 39]. BPM has been widely used by organizations from the most diverse sectors of society, including in the education sector, since there have been several case studies that refer to and justify their use in the context of HEI [40-42].
BPM presents the essence of the business process, which is characterized as the aggregation of activities and behaviours performed by humans or machines, which generate value for the business, with the aim of achieving one or more results. A business process receives a set of inputs that transforms into outputs and can be composed of one or several interrelated activities that aim to solve a given problem, which are subjected to business rules and, in a given context of relationship, orchestrated and coordinated, have a sequence and a flow [43].
This approach allows for visibility and understanding of business processes, often at the cost of graphically representing the activities that constitute the business processes, using predominantly flowcharts, Business Process Model and Notation (BPMN) or Unified Modelling Language (UML) (with emphasis on activity diagrams) [44].
In addition to the use of BPM, it is common to use other work structures, methodologies or tools for the purpose of defining, designing (workflow), executing, monitoring, analysing and controlling business processes. Some of these examples include: Enterprise Architecture (EA) [45]; Lean Six Sigma (LSS) [46]; SERVQUAL method [47]; and Balanced Scorecard (BSC) [48]. Among the examples mentioned, EA is one of the most used options to complement the BPM and has aroused interest both in the business community and in the academic world, especially in HEIs all over the world [49-52].
A useful and interesting example of applying an AE for the management of the IS/ICT binomial (indexed to the scope of e-Governance) and the business processes of an HEI is the model proposed by [11]. This model (later applied according to the reality of a Portuguese public HEI - UTAD) is characterized as being multidimensional, because, for the authors, it would become reductive to make an AE that only contained the mapping of IS/ICT, without there being a framework with the organizational dimensions to which they are associated.
This AE allows the identification of flows of information on a holistic and integrated perspective, contemplating the intended visions of a given fact/event, through the different organizational levels (operational, technical, tactical and strategic). In addition to the IS/ICT mapping, it is still possible to visualize the logical and procedural

component associated with this information management. The logical component is built from the multiple areas that make up a certain dimension of the organization and the procedural component is characterized by the tasks and functions performed by the actors (technical specialist, technical manager, functional area manager and top manager) [6].
The growing number of students (and devices used by them) in the world in higher education, partly motivated by the encouragement of internationalization policies [53], requires that investment and development in e-Governance meet quality standards which guarantee the excellence of the resources made available and the services provided [54]. In this sense, the adoption of international norms and standards oriented to quality certification will enable HEIs to invest in e-Governance and to develop/innovate the IT/IT binomial according to their needs, strategic objectives and services provided. At the same time, the academic community will be able to obtain a better experience of using resources and services, thus increasing their satisfaction [33].
The International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC) have been widely used in the application of standards and quality standards in HEIs, namely: 9001, 20000, 21001: 2018 and 27001 [55-58].
The ISO/IEC 9001 standard aims at the certification of quality management systems and defines the requirements for their implementation. It adopts a business process-oriented approach that incorporates the continuous improvement Plan, Do, Check, Act (PDCA) cycle and integrates risk-based thinking. In the context of HEIs, this standard applies to transversal services (e.g., academic services, human resources services, financial and material services). On the other hand, the use of ISO/IEC 21001:2018 complements the previous standard, as it applies to the teaching and scientific component of HEIs and applies to the quality management of teaching, learning and research systems.
The ISO/IEC 20000 standard focuses on IT management issues through a helpdesk approach, that is, problems are classified, helping to identify current issues or interconnections. This standard is divided into two parts: 20000-1, which is the formal specification and defines the requirements for organizations to provide quality services (service provision, management and change processes, relationship, resolution and control processes); and 20000-2 which is the code of practice that describes best practices for service management processes and is especially useful in audits.
The ISO/IEC 27001 standard is directed towards the definition of standards oriented to information security. This standard assumes as the main objective the adoption of a set of requirements, processes and controls that allow to properly mitigate and manage security risks.

4. The case study - UTAD

4.1. The institution

UTAD is a Portuguese public university, created in 1973 in the city of Vila Real, considered one of the main institutions promoting the development of its region, both for its scientific and technological contribution and for the entrepreneurship it has been encouraging. Assuming the university status, UTAD is defined as a multidisciplinary institution that promotes a critical analysis, necessary to leverage the transformations of the society, constituted by spaces dedicated to the thought, as well as to the deepening and convergence of several branches of knowledge, corresponding to areas of knowledge.
As a university institution, UTAD intends to ensure a broad scientific preparation that is the basis for a solid technical and cultural training necessary for the professional insertion, aiming unceasingly for the search of new knowledge and for the promotion of scientific production. In addition to UTAD taking a proactive attitude in the building of scientific

and cultural heritage, its mission coincides with three complementary actions, namely: 1) the creation, promotion, transmission and diffusion of culture, science and technology; 2) the promotion of scientific research and the preparation of a sustainable and sustainable environment (thus moving in the right direction to build an eco-campus), conducive to study and reflection; and 3) promotion of the provision of services to the community, in a perspective of reciprocal appreciation.

Given the complexity of the operation of the strategic plan of UTAD and the growing competitiveness of the university environment, both nationally and internationally, the institution has focused on e-Governance (and consequently IS/ICT binomial). This HEI considers that the investment in this area will allow to support its business functions through the availability of reliable, correct and accurate information, which transits preferentially in synchronous (or asynchronous) way across the various functional areas/departments and other dimensions (e.g., Pedagogy, Teaching , Innovation/Entrepreneurship and Research), making its operations more efficient and efficient, helping in informed decision making [11].

3.2 Investment in e-Governance

Since its inception, UTAD has closely monitored developments in the areas of e-Governance, recognizing the potential and positive impact that the application of these areas could bring to the institution's performance and quality. Otherwise, this HEI considers that the technological impact could bring several benefits, namely with respect to increasing agility and responsiveness to the academic community, efficiency in the performance of tasks (operational and management), while enhancing the modernization and reducing costs.

The development of projects of this nature emerged according to the needs of the institution, but its implementation occurred only when the existing technology allowed it. In some IS/ICT projects, this HEI has been very open to the community and had the support and cooperation of partners (eg. agencies, institutions, HEIs, companies) and collaborators (eg. Teachers and researchers) that originated important contributions to the achievement of the UTAD objectives.

Considering the whole history of the evolution of e-Governance and of IS/ICT in UTAD, it is possible to emphasize that since 2004 there has been a greater interest and investment (and more regular), which has led to its proliferation, development and application in different levels of performance of the institution. This situation has been verified up to the present day. The following timeline show a brief presentation of the main projects in which UTAD has developed and participated that fall in the period between 2004 and 2019 (see Fig. 1).

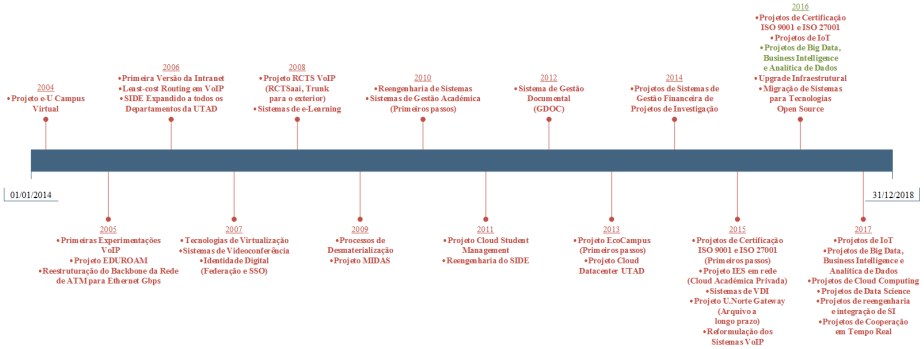


Fig. 1 Timeline of e-Governance evolution at UTAD (2004-2018)

The year 2004 was marked by the participation of UTAD in the e-U Campus Virtual project as pilot IES, an initiative proposed by the Agency for the Knowledge Society IP (UMIC) and technically coordinated by the Foundation for National Scientific Computation (FCCN) which aimed at the creation of an extensive wireless network, integrating the Portuguese HEIs into a single “virtual campus” with more than 5000 access points, using interinstitutional roaming, with the objective of providing services, academic content and applications (complying with World Wide Web Consortium - W3C

accessibility guidelines) to students, teachers and researchers, including those from their own institution, if they are displaced.

UTAD, in order to rationalize its voice communications and, in view of the dispersion of its campus and poles (located in the cities of Chaves, Miranda do Douro, Vila Real town centre and SAS-UTAD), started in 2005 the first VoIP pilot, connecting the central Time-

division Multiplexing (TDM) (traditional) with IP backbones, emulating point-to-point links, thereby reducing internal communications costs. This year was also marked by the participation in the project Education Roaming (EDUROAM) proposed by TERENA, and is revealed as the natural evolution of the e-U Virtual Campus project, with the main objective of providing a mobility service between institutions of the European academic community (currently extended to more than 110 countries worldwide), guaranteeing the connection to the Internet, through the wireless network, in a transparent way, regardless of whether a user is in the premises of his institution or in another academy adhering to the project.

The introduction of the first version of the UTAD's intranet comes in 2006, where the first steps were taken towards the dematerialization of processes, centralization and management of academic content and implementation of communication strategies and internal cooperation. This year, there was also an evolution in VoIP projects previously established, introducing the concept of least-cost routing, which allowed the execution of calls between UTAD and abroad. After having been validated the usefulness of the Information System to Support Teaching (SIDE), used until then by the Engineering Department of the institution for academic management and to support the teaching and learning process, this IS expands to all departments of the academy.

The following year, the main highlight is the data centre consolidation project, which aimed at the renewal of storage technologies and bets on virtualization technologies. The previous architecture was not very dynamic (100% physical), so the new solutions introduced came to fill four basic constraints: redundancy and backup; hardware oversizing (and consequent performance issues); maintenance (preventive and reactive); and energy efficiency. In addition to this project, this year the institution began to implement federation and identity management mechanisms in his IS (digital identity), guaranteeing the reliability and security of users' data (incidence for the use of SAML, Single Sign On (SSO) and Shibboleth standards/initiatives). At this point, there is also a project for the creation of videoconferencing rooms and systems for remote collaboration.

The year 2008 was marked by the participation of UTAD in the project Network Science, Technology and Society (RCTS) VoIP and by the institution of the first systems of e-Learning. At the same time, projects have come up with advanced features such as RCTSaai, an authentication and authorization infrastructure that aims to simplify access to web services for the entire RCTS community. The second project is related to the adoption of Moodle as LMS solution, being used to provide internal training and some courses in the educational offer.

In 2009, the focus of the IS/ICT projects was the dematerialization processes, where some of the services provided by the university began to be carried out digitally through applications, portals or e-mail (e.g., access to tuition receipts, renewal of student enrolments). The intranet has also undergone changes, adding capabilities for document processing, and is no longer used primarily for internal communication purposes. In the scope of this type of projects, another one called MIDAS was developed which consists of dematerializing a significant set of administrative processes, using citizen's card and digital signature, in order to digitally manage the life cycle of the documents that support the processes, guaranteeing efficiency and effectiveness of the services provided by the various functional units of the institution.

In the year that marked the end of the first decade of the new millennium, the first steps were taken to implement an integrated academic management system. This is a back office system for the effective and centralized management of the academic area, which allows the monitoring over time of all activities of the institution in its multiple aspects: academic (management of students and teachers), administrative (e.g., courses,

disciplines, curricular plans), and the counter and accounting (treasury). Some of the ISs in production used by the functional areas of UTAD underwent reengineering processes. The SIDE service provides a fundamental aid to the teaching and learning process, so in 2011 an application was submitted under the name Cloud Student Management, aiming at reengineering software, restructuring the database, creating multilingualism, the implementation of alerts, the issuance of guidelines in digital format, the issuance of certificates, the integration with LMS technology and the consolidation of information exchange between systems.

The apogee of dematerialisation projects is reached in 2012 with the GDoc project, which has made it possible to reduce the large volume of processing of information and procedures, both in paper and in digital format, reducing the consumption of resources, time and costs associated with personnel management, processes and documents.

The year 2013 would be reserved for one of the most ambitious IS/ICT projects in which UTAD has been involved in recent years, called the UTAD Green Cloud Datacentre and with the acronym UTAD Cloud Datacentre. This project aims to create a new datacentre for the support of cloud environments (using open source technology). This year, the first steps were taken in the EcoCampus project, with the introduction of water and energy management systems and real-time monitoring of the quality of electric energy, as well as energy audits and building air quality and campus.

Research is one of the main pillars of HEIs, and in view of the criticality of research projects, in 2014, projects were started that aimed at the creation of IS for financial management of research projects.

In order to demonstrate its commitment to the quality of services provided (and its IS), academic community satisfaction and information security, in 2015 UTAD took the first steps towards ensuring compliance with ISO 9001 and ISO 27001. Another of the main IS/ICT projects designed this year was the networked IES (Private Academic Cloud) project, which had the partnership of other Portuguese HEIs. In addition to this partnership, another was established, this time within the scope of the consortium U.Norte.pt, and the U.Norte Gateway project was created for the administrative modernization and consolidation of the resources allocated to the management and preservation of the information generated during the years, establishing a digital archive in the long term, which led to total dematerialization. In addition to these projects, UTAD has developed others in the area of Virtual Desktop Infrastructure (VDI) and VoIP (incidence for unification and rationalization).

In 2016, work was continued on projects to comply with ISO 9001 and ISO 27001 standards. In addition to the certification projects, the emphasis of IS/IT projects fell on Internet of Things (IoT), Big Data, BI (focused on IT infrastructure management) and Analytical data, aligned in part with the EcoCampus project. There were also projects that privileged the IT component, with the existence of an infrastructure upgrade, and the migration of systems to support open source technologies.

In the year 2017, due to the interest in the continuity in the remodelling of UTAD in the area of e-Governance, projects related to the construction of EA were developed. The development of projects such as the one developed by [11], allowed to identify some gaps in the way ISs work and interact with each other. In the last five years, UTAD has increased efforts in the creation of knowledge and intelligence for management and decision making [59]. Therefore, for 2017 and beyond, applications for IS/ICT projects predominate in the areas of IoT, Big Data, BI and Data Science. In light of the investment made in cloud technologies, some projects related to Cloud Computing will also be set up. Finally, part of the investment in IS/ICT will fall into real-time collaboration projects

(e.g., document sharing, content delivery). From 2018 until now the focus has been on quality management and obtaining ISO/IEC certifications.

4.2. Identified needs and motivations

One of the most critical tasks performed in UTAD ICT Services is user support and, given its complexity (see Fig. 2), it needs to be assisted by an IS that allows the ICT Services to obtain the maximum information about the requests, so that they can become more expeditious and informed, and thus provide a faster and more efficient service, which provides a better experience for users. Within the scope of e-Governance that has been developed at UTAD, one of the services that has been the focus of most attention is the infrastructure management (ITSM), materialized through a ticket system, since it is one that allows to check if the services provided meet the quality standards to which the institution is being certified.

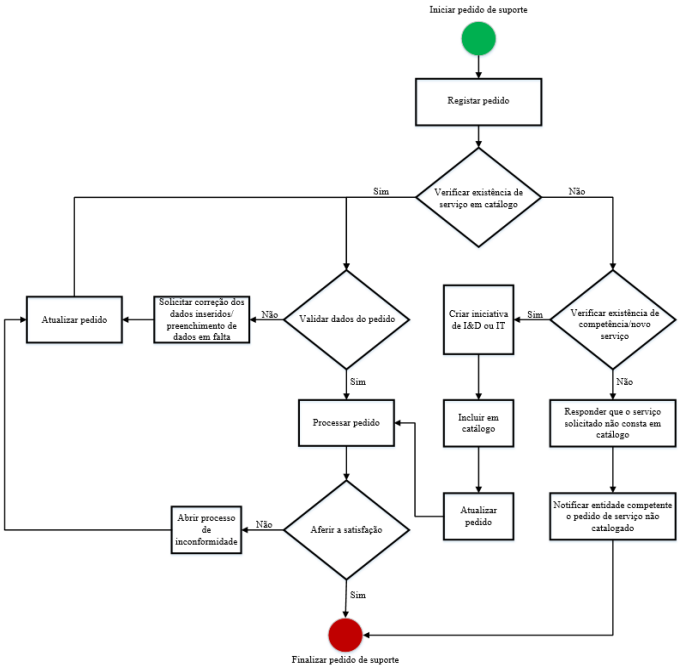


Fig.2 Flowchart of the request for support to SIC-UTAD

In the service to the users, the faster the capacity to respond to their problems, doubts or difficulties requested, the greater will be the satisfaction obtained with the service provided. In this sense, the UTAD ICT Services adopted a helpdesk system to better manage and organize the service of users who request their intervention. The system adopted is an IS that, in general, allows these services to obtain efficiencies in the reception, processing and response to the requests of the users of the academic community through tickets, by centralizing the management of the entire process.

The use of this type of system allows these services to obtain several benefits such as increased communication channels, improved communication with users, standardization of responses and reduction of information losses since the requests are archived and centralized in the same place. In addition to these benefits, these services are also able to: provide, accountability, transparency and excellence in responding to requests; supervised delegated tasks and fulfil associated deadlines; decrease the cost of service through other means (e.g., telephone); control the average time spent in solving the available under the catalogue of services (in order to meet the institutional requirements related to quality); decrease the number of technician intervention; and let agents know the behaviour of users through their ticket history (see Fig. 3).

Fig. 3 ITSM used by SIC-UTAD (perspective of the requested requests)

Regarding the features that this system presents, some of the main ones are the following: ticket creation and his assignment to a specialist technician; creation of automatic responses; e-mail notification of new tickets; definition of workflows; visualization of the history of the evolution of the requests and the information related to the actions carried out; creation and customization of templates; creating reminders; division and merger of tickets; assignment of collective management of tickets; define states and priorities; attach files in various text and image formats; define permissions and access; registration of internal notes; alarmist customization; evaluation of care; creation of reports; export of files (eg. ticket history for the last six months); validation of tickets; creation of some performance and demand indicators; and support for SSO.

This system is used in the UTAD ICT Services in two of the levels of the architecture proposed by [11], namely in the Operational and Technical levels, in the first one it is applied to perform registration and monitoring tasks, while in the second it is used for the creation of reports and validation of records created at the lower level.

In the context of decision-making processes related to user support, the following main information needs were identified: the temporal evolution of the number of support

requests; the period in which there is a greater occurrence of requests for support; which employees respond to more support requests; the status of the support requests (and number of open/closed tickets); gauging the efficiency of technicians; the average response time to support requests; the users who request more technical support (and if the reason varies or is recurrent, and can later direct questionnaires to measure satisfaction); the heights of the year with more requests for support, allowing to size the service of the technicians; the requests for support that are not in a catalogue whose request is recurrent so that they can be included in the catalogue of support services in the future, if it is concluded that the requested competence can be performed by the UTAD ICT Services, taking into account the internal regulations of the institution; the type of most requested support requests, so that the support catalogue is adequate to the most recurring needs; and the most requested support services so that the skills of the technicians can be adapted.

4.3. Tests and results

Throughout this subchapter it will be presented the test battery that was executed on the BI/SSBI architecture developed for the UTAD ICT Services [59], identified in the tactical/strategic levels of the EA proposed by [11], as well as the consequent key performance indicators (KPIs) that are fundamental to the decision-making support of ICT infrastructure management and user support processes.

The objective of the tests was to construct visualizations and dashboards that allowed data to be crossed, allowing the analysis of the main indicators considered essential and determinant, so that the necessary knowledge was created so that UTAD, and more specifically to permit to the UTAD ICT Services make decisions, to effectively and efficiently manage their ICT infrastructure and to better support the users of the academic community to which it belongs, thus helping to fulfil the quality certifications to which it is associated.

During the creation of the visualizations and the dashboards under test, some care was taken to respect the theoretical principles presented in the bibliographic review, wherever possible it was chosen by graphic elements to textual elements, darker colour tones, non-serif texts and simple predominance for bars, lines and circles.

Regarding the data that will be exposed, these relate to the ITSM service, they are real, but they are not the most current because, the institution understood that this would be another way to mitigate possible security risks that would disrupt and compromise the operation of the systems and keeping privacy under mind.

After identifying the main management needs of the UTAD ICT Services related to the user support service, a set of indicators and dashboards were created, in order to support their decision-making processes in a more expeditious way and informed. The data that fed the indicators and dashboards that will be presented next, are composed by a sample of 3,273 of logs, coming from the service of ITSM and framed in the interval of 01/01/2016 to 05/12/2016.

From the sample of the 3,273 logs, it was verified that up to December 12, 2016 3,187 requests for support requested by the users had been successfully closed. The months in which there were more requests are related to February (519), September (451), October (403) and November (292) . These months are the ones that have the greatest influence, since they mark the main changes in academic level, namely the different phases of the beginning of the school year (1st phase in September, 2nd phase in October and 3rd phase in November) and the change of semester (February), so these times of the year require the availability of a larger number of technicians.

On the other hand, through the analysis of Fig. 4, it can be seen that the months in which there are fewer support requests are May (184), July (135) and August (82), since they correspond to the months to at the end of the academic semesters, which means that these are the ideal months to plan training or develop other activities related to the competences of UTAD ICT Services.

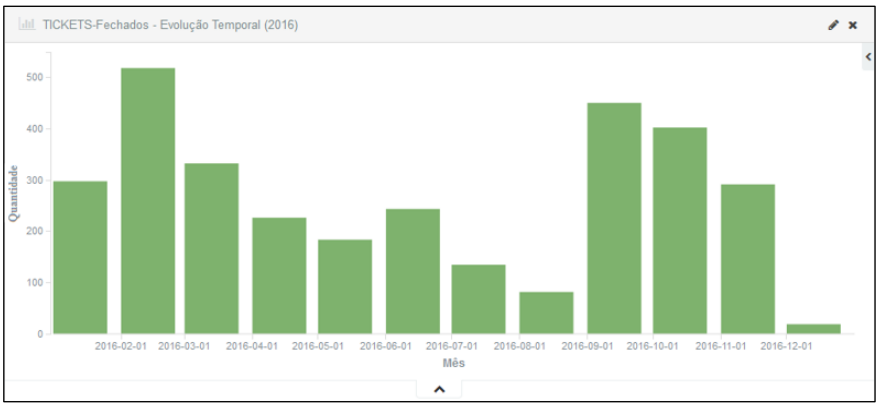


Fig. 4 Monthly evolution of the number of closed tickets

On the other hand, from the analysis made to Fig. 5, it was observed that 86 tickets remained open, dispersed throughout the months of the year except for January. The months with the highest number of tickets to close are May (12), November (19) and December (12). Given that the data were collected on 12/5/2016, the months of November and December are presented as having the most tickets to close due to the proximity to the date of collection. The main reason for tickets to close almost every month is the forgetfulness of the technicians, who after providing the support to the users, sporadically do not close them.

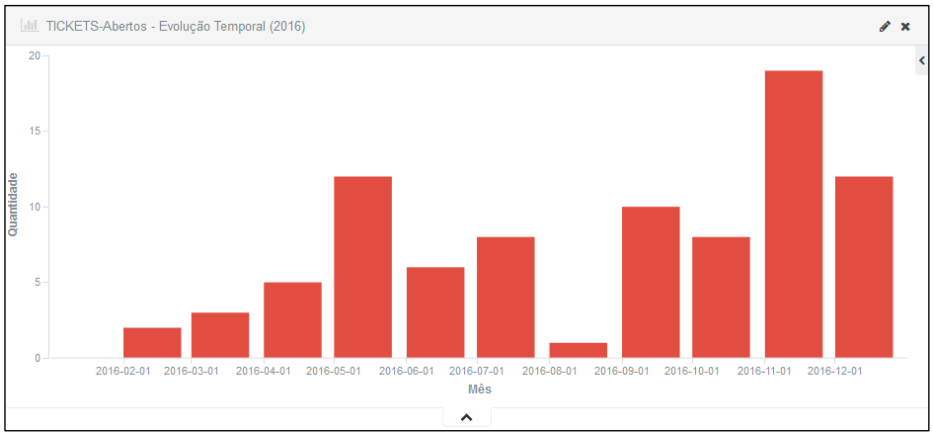


Fig. 5 Monthly evolution of the number of open tickets

The indicator shown in Fig. 6 is associated with users who have more support requests associated with them. Through this indicator you can see which users have made the most use of the support service and which technicians have responded most to requests for support. With respect to the first case, it allows to verify (later) if the reason that causes a user to resort frequently to the support service is always the same or if they vary and direct him questionnaires to gauge their satisfaction. Regarding the second case, it allows subsidizing the technicians who answered more support requests.

In the future, it would be interesting to store separately on the ticket platform the data associated with the user requesting the support request and the data associated with the technician who will respond to this request, as it is currently not possible to check the user-technical relationship. At the moment, these data are related to the same attribute (user), this is because, in most cases, the request for this service is made personally by the users at the service desk, so it is the technicians who end up opening the tickets with the that they have in the system. From the analysis to Fig. 6, it can be seen that the top 10

of users with the highest number of tickets (closed) is populated by UTAD ICT Services technicians, representing 54% of the sample.

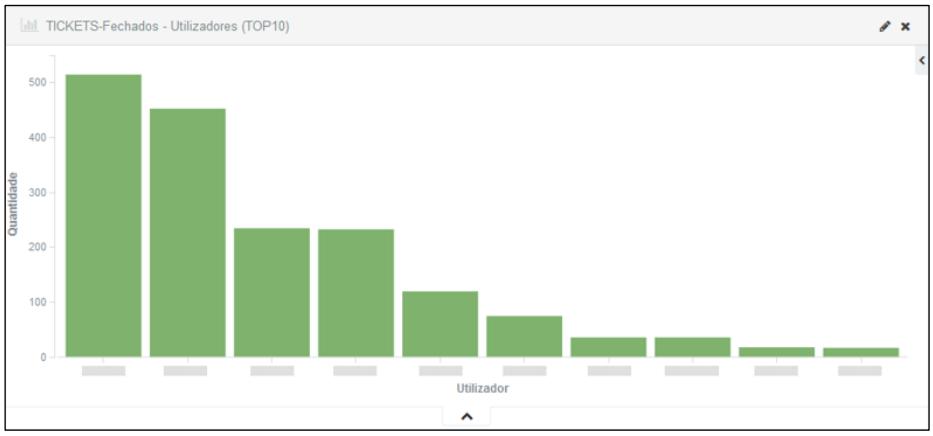


Fig. 6 Top 10 ticket system users who have more support requests associated

For the management of this service it is also important to understand which are the most requested types of user support. For this, the indicator shown in Fig. 7 was created, which reflects the 10 most requested types of user support (closed tickets). From the analysis to this graph, it can be seen that there are only six types of support available to the user, in descending order of request: "User Support" (1,997 requests), "Infrastructures and Communications" (632 requests) "SIDE" (520 applications), "Videoconferencing System" (21 requests), "Secretariat" (14 requests) and "Computer Services" (3 requests).

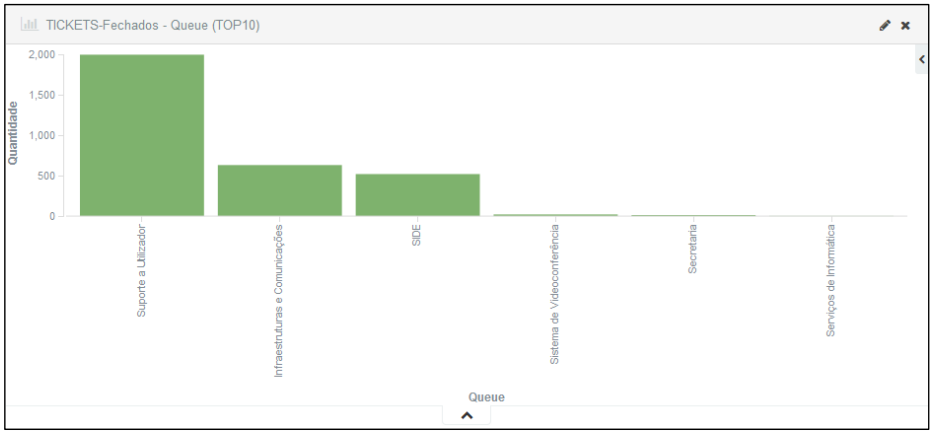


Fig. 7 Top 10 types of user support

In addition to the information about the main types of support requested by the users, it is also of interest to understand the main services requested within each type, which is why the indicator present in Fig. 8 (closed tickets) was constructed. From the analysis to this indicator, it is concluded that the most requested services for each type of user support are (presented in descending order of the number of requests):

- User Support: “Wireless Support and VPN” (537), “Software Installation” (502), “User Support” (358), "User Network Support (e-mail and other services)” (60);
- Infrastructure and Communications: "Connectivity and network" (248), "Digital identity" (66), "E-mail systems and quotas" (63), "Infrastructure support");
- SIDE: "Service to students" (211), "Managers and course direction" (127), "Services to teachers" (93), "SIDE technical support" (45);
- Videoconference System: "Scheduling" (20);
- Secretariat: "Generic subjects" (1).

It should be noted that in this indicator there are no results associated with the type "IT services", because the only three tickets of this type had not specified the service that was intended. With this indicator it is possible to perceive the types and services of support most requested, so that there is an update of the catalogue and adaptation of the skills of the technicians (designing training courses), based on what is most requested.

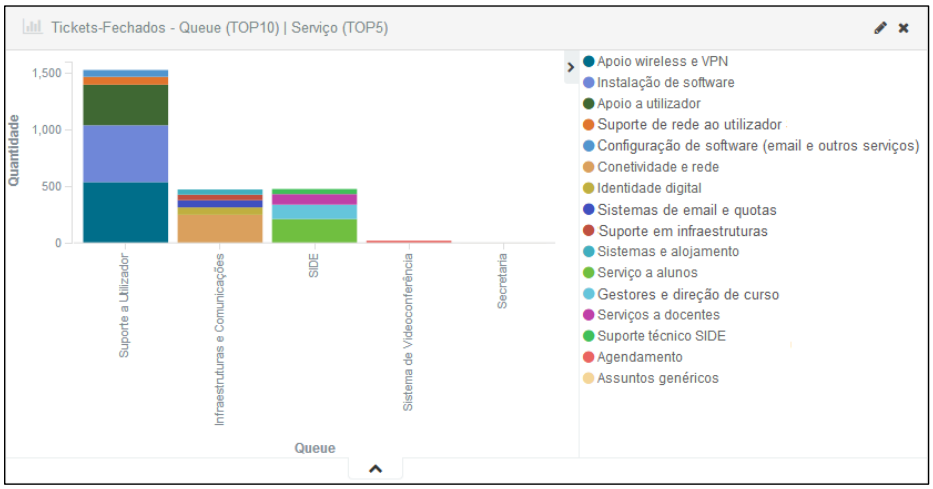


Fig. 8 Top 5 most requested services by each type of user support

Fig. 9 presents information relating to the more detailed description of the support request, being stored in a field of the free filling ticket (which makes descriptions referring to it in the Top 10) appear. This information is important because, it allows the technician to perceive in more detail the support that needs to provide the user. On the other hand, this information makes it possible to understand which requests for support are not in the catalogue and whose application is recurrent, so that they can be included in the future, if it is concluded that a request falls within the competencies of SIC-UTAD. Analysing this table, it can be demonstrated that the main top 10 requests for tickets are related to software installation (46%), wireless network setup/configuration (42%) and problems with filling in the forms with the students' grades (7%).

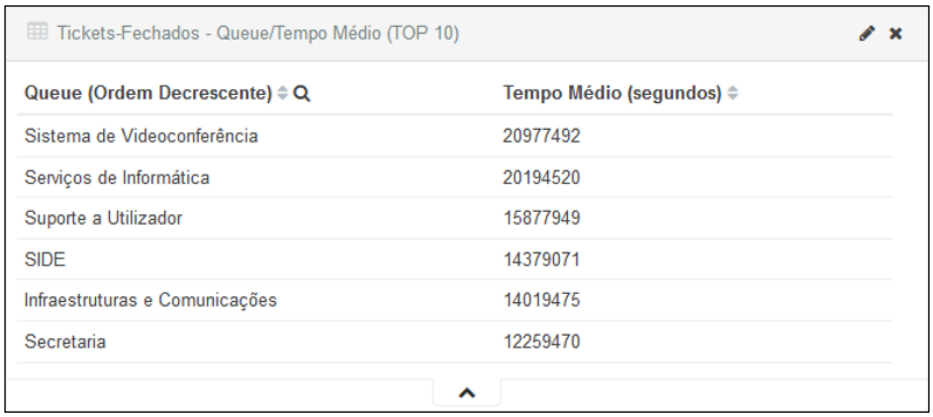
TICKETS-Fechados - Principais Pedidos (TOP10)

Pedidos (Ordem Decrescente)	Quantidade
Instalação Software	76
Configuração do Wireless	75
Instalação de software	73
Instalação wifi	49
instalação de software	38
Configuração do wireless	35
Instalação do wireless (rede sem fios)	32
Problema com preenchimento de pauta	32
Instalação de Software	27
Rede	25

Fig.9 Description of main user support requests

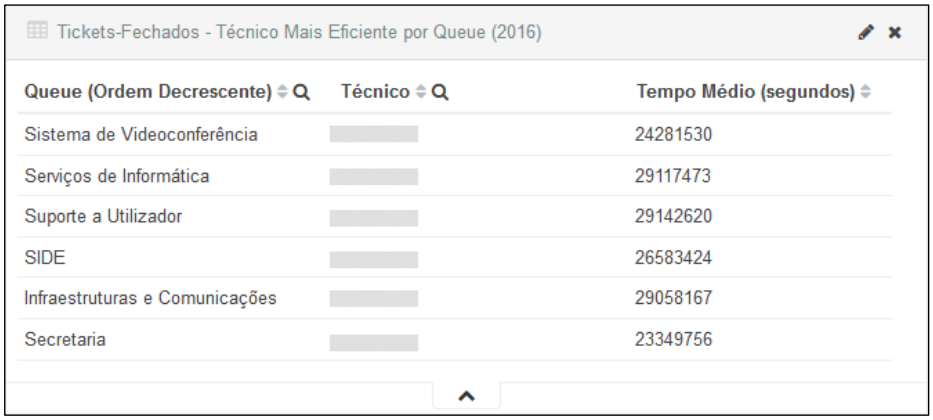
The knowledge that can be extracted from the information provided by the indicators of

Fig. 8 and Fig. 9 is of extreme importance because it allows technicians to construct procedures manuals, based on the largest and most recurrent needs that users present (e.g., installation and VPN configuration for different operating systems).
The last indicators presented for this type of data are related to the average time each type of support takes to execute (see Fig. 10) and to the efficiency of the technicians in the support to the users (which is the most efficient technician by type of service) (see Fig. 11). These indicators are extremely important for measuring the performance of technicians, since their efficiency is a very important factor both in assessing the quality of UTAD ICT Services and in ensuring the satisfaction of those who receive the service. The analysis to Fig. 10 reveals that the type of user support that involves the most time to be provided is relative to the "Videoconference System" (~ 5.8h) and the fastest is relative to the "Secretariat" (~ 3 , 4h). The other types of user support, in terms of efficiency, are decremented by "Computer Services" (~ 5.6h), "User Support" (~ 4,4h), "SIDE" (~ 3, 9h) and "Infrastructures and Communications" (~ 3,8h). For privacy issues, the most efficient technicians by type of user support will not be revealed in Fig. 11.


Tickets-Fechados - Queue/Tempo Médio (TOP 10)

Queue (Ordem Decrescente)	Tempo Médio (segundos)
Sistema de Videoconferência	20977492
Serviços de Informática	20194520
Suporte a Utilizador	15877949
SIDE	14379071
Infraestruturas e Comunicações	14019475
Secretaria	12259470

Fig. 10 Average run time per type of user support


Tickets-Fechados - Técnico Mais Eficiente por Queue (2016)

Queue (Ordem Decrescente)	Técnico	Tempo Médio (segundos)
Sistema de Videoconferência		24281530
Serviços de Informática		29117473
Suporte a Utilizador		29142620
SIDE		26583424
Infraestruturas e Comunicações		29058167
Secretaria		23349756

Fig. 11 Most efficient technician by type of user support service

After having presented some of the main indicators obtained for this type of data, then two dashboards will be available (see Fig. 12 and see Fig. 13) that allow to withdraw knowledge regarding a certain user and a certain technician.

The dashboard of Fig. 12 presents indicators related to the tickets associated with a specific user who requested the support of the technicians of the UTAD ICT Services, which allow to extract: number of open and closed tickets, the time evolution of their requests and the average time involved your resolution, which types of support (and their services) you have resorted to, and the more detailed description of the applications (Top 10).

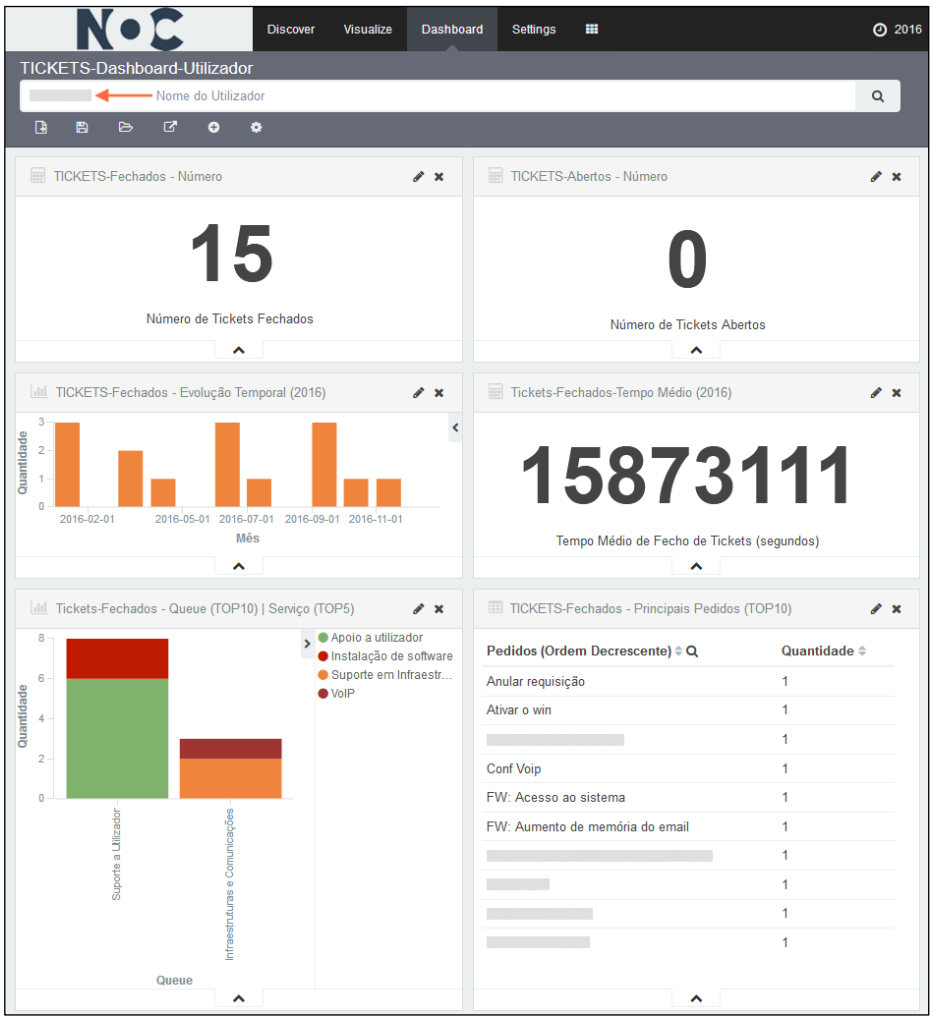


Fig. 12 Dashboard on support for a user

The dashboard of Fig. 13 presents indicators related to the tickets associated with a certain technician of the UTAD ICT Services who responded to requests for support, which allow to extract: number of tickets opened and closed, the time evolution of their tickets (open and closed), the average time involved in their resolution, the types of support (and their services) that best fit their interventions and the more detailed description of the applications (Top 10).

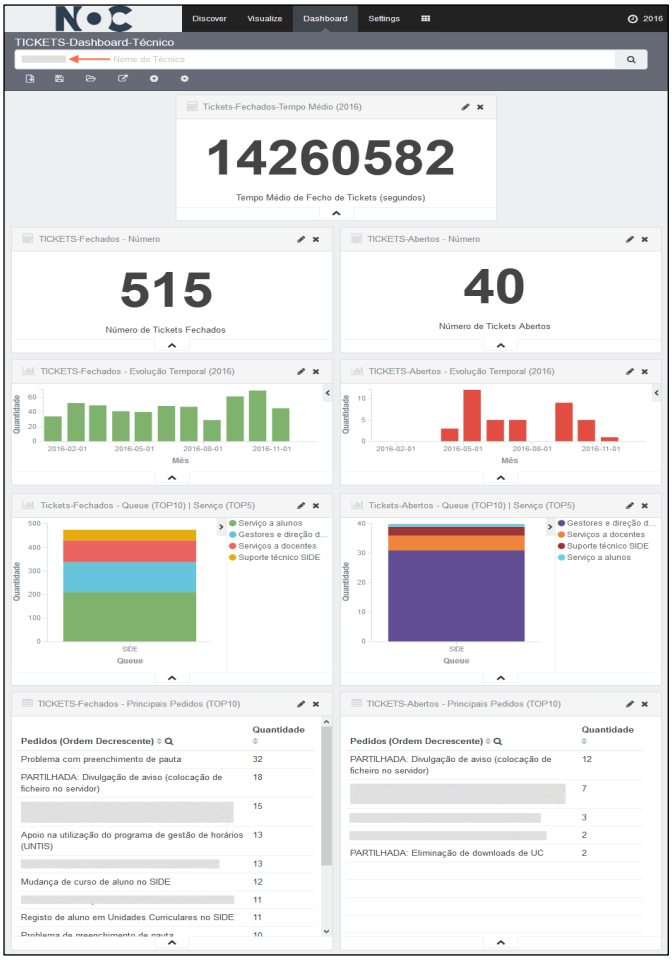


Fig. 13 Dashboard for providing user support to a technician

5. Final considerations and future work

The ability to manage and create information is at the heart of the differentiation of organizations and the creation of competitive advantages, so that the use of ICT is combined with the intervention of the IS in order to optimize and support these processes. The ISs being supported by ICT in their technological aspect, were able to meddle in the fields of management and organizations, characterized by the execution of a set of procedures for the production of information, causing impact in the management of the organizations through the dynamization of their operation, boosting their development as active socio-economic agents.

In order to reduce the inertia of services rendered by public sector organizations and to make them more efficient and productive, investment in IS/ICT has been increasing, introducing the concept of e-Governance. This growth has been verified in different areas, as is the case of Education. In this context, HEIs face the challenges they face daily, they need to invest in this technological component. In HEIs in general, and in Portuguese in particular, a great investment in IS/IT has been made, as is the case with UTAD (case study), which in the last 15 years has modernized and converted to digital many of the services it provides to academic community, often changing the form of interaction and communication with users.

In the management of e-Governance , the use of BPM is very useful, since it allows defining the processes and their stakeholders, allowing to design in a more effective and well-defined way the development of IS. On the other hand, the EAs are an auxiliary element in the evolutionary process of e-Governance, since they allow the mapping of IS/IT resources, as well as the identification of how they relate, allowing an overall view of the functioning. This type of architectures also allows to identify with greater effectiveness the degree of connection between the systems, as well as to identify the need for integration among them, and also allow a future-oriented management, with the

identification of development priorities and investment in this field.
Based on BPM and EA, namely the one proposed by [11], and given UTAD's need to ensure international quality certification in its services, the need to invest in the IT management and user support system was identified (ITSM), especially with regard to the production of knowledge for the aid in the decision-making process.
The tests carried out on the ITSM service data, based on the vision obtained through the use of the AE used, allowed the construction of management indicators, such as: the

existence of more requests for support during the months of student enrolment, with a marked decline in the months following these periods; which technicians and users are involved in more support activities; the most requested types of support were "User Support", "Infrastructures and Communications" and "SIDE"; and the support services with the shortest response time were those related to the requisition of the videoconference system and provision of computer services. Dashboards were also built that allowed the profile of a technician and a user to be drawn.
In its strategic planning for the coming years, UTAD presents a strong and dedicated component of IS/ICT investment, since it considers that the modernization of the technology park and the development/renovation of the digital services that it provides to its community are extremely important for the guaranteeing the quality of services provided to an increasingly demanding academic community and, on the other hand, the commitment in this area of e-Governance will allow the institution to meet quality standards required in certification processes. As future work it would be interesting to continue to monitor the extent to which the use of BPM and AE as proposed by [11] are useful tools to delineate the development of e-Governance both in UTAD and in other Portuguese HEIs, and what their effects are administrative modernization and quality management (and certification) of the services provided to the community.

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1. AUTHORS' BIOGRAPHIES

António Costa – Is an ICT specialist at (UTAD), Vila Real, Portugal, and is responsible for the coordination the areas of core infrastructure and communications, computer security areas, datacentre, VoIP and communications networks. He collaborates in teaching on different degrees of computer courses, as well as in research, extension and development projects. Holds a degree in Electrical Engineering (specialization in Electronics, Instrumentation and Computation) and a post-graduate degree in engineering area. Currently, he is in the final research stage to complete the PhD in Computer Sciences. He made several made courses or specializations which includes the Upper Course Director for Public Administration; Diploma of specialization of the Information Society for Public Administration, SIP Masterclasses, OpenStack and Data protection Security specialization.

José Bessa is an Information Systems completed his Master from the University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal. He is currently researching Information Systems Architectures and Network Communications aiming the to complete his PhD. Besides this, implements Business Intelligence (BI) and Self- Service BI solutions.

Alberto Vasconcelos - Is an ICT specialist at (UTAD), Vila Real, Portugal, with responsibilities in cloud implementation and administration.

Elsa Justino – Has a PhD in Social Work. The professional experience includes the positions held in the service commission as Vice-President of the Student Support Fund, Deputy Director General of the General Directorate of Higher Education and Head of the Office of the Secretary of State for Employment and Vocational Training. She is currently Administrator of the University of Trás-os-Montes and Alto Douro and of the Social Action Services. In the field of higher education he has regularly participated in studies, communications and scientific articles on students, social action and higher education