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INFORMATION SYSTEM TO SUPPORT QUALITY MANAGEMENT SYSTEMS: A CASE STUDY IN A PORTUGUESE HIGH EDUCATIONAL INSTITUTION

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Abstract

The application of Quality Management Systems – QMS, particularly the ISO 9001 standard, in organizations allows the definition of a set of organizational documentation to guide and achieve high levels of efficiency, improve the services’ performance and to improve the internal and external quality of the services provided. However, the definition of these type of standards requires a large set of documentation that presents some difficulties in their application like: the access to the correct document (form or procedure) in order to perform a task or provide a service; long time to fulfil the forms and long time to analyze the information to get the key performance indicators associated to the objectives of that standard. Considering the advantages and the emergent evolution of the Information Systems (IS) these types of systems present a good solution to resolve the difficulties of the implementation and application of QMS in the organizations. This paper presents a case study of the application of an IS to support the usage and implementation of the QMS in a High Educational Institution. With the implementation of the IS, the Institution improved the qualification of the administrative services, reduced the search time of the correct documents to perform a task, reduced the time to complete the forms, enabled a direct iteration with the users and the services allowing the schedule of actions by the administrative services to respond to the requests, and also reduced drastically the usage of documents in paper format.

Keywords: ISO 9001 Standard, Information Systems, Information Systems Development, Quality Management Systems

1 INTRODUCTION

The implementation of Quality Management Systems (QMS) standards in particular the 9001:2000 (ISO 9001) (Cianfrani, 2000) brings many benefits for organizations in terms of documentation and procedures to ensure the desired satisfactory level of services provided internally and externally by the organizations, guide the collaborators to perform the services in a correct manner, analyze indicators to monitor the performance of the services and delineate actions to improve the performance, efficiency and accuracy of the services. Traditionally, all guidelines of these standards are materialized in large sets of documents, procedural flows and forms that reflect the activities of the organizations. Moreover, such standards outline a set of Key Performance Indicators (KPI) in order to monitor the services that are in general obtained through the records associated to the forms requests and procedural tasks executed by the services. Despite the advantages of the definition and usage of the documentation associated with that standard, there are several difficulties in its usage and implementation, namely: to request a service is commonly necessary to select and complete the correct form (traditionally in paper format without digital support) or select the correct procedure to execute a task. Considering the large set of documentation it is in many situations difficult to quickly find the correct document and to complete the necessary fields of the form in situations where the form has many fields. These situations imply the loss of time to search and fill the information; When the organization has many departments dispersed geographically it is difficult to centralize the information, and control all records; difficulty to obtain the KPI because it is necessary to concentrate all information to monitor such indicators.
Therefore, besides the advantages of the application of QMS standards, many factors could influence their success.

Traditionally, organizations move their activities by the need to produce high rates of performance, efficiency and accuracy, the satisfaction of their employees, customers and suppliers in order to be competitive and to enable them to face competition and ensure their survival. With the advantages of the Information Systems (IS) and Information Technologies (IT), organizations increasingly based their activities in these systems and technologies to record, monitor and analyze information to guide their activities to improve the performance objectives and to resolve many difficulties in internal services to achieve the performance objectives.

Considering the difficulties of the application of the QMS (ISO 9001 standard) and the advantages of the IS, this paper presents a case study of the definition and implementation of an IS to support the usage and application of the QMS in a High Educational Portuguese Public Institution. With the implementation of this IS the Institution could implement efficiently the QMS and resolve many difficulties associated to the application of the QMS.

This document is structured as follows: in section two we give a short overview of the implementation QMS standards in particular ISO 9001 as well as the description of the QMS implemented in a High Educational Public Institution. In section three we present the implementation of the IS in the Institution giving the context of the applicability of the project, the initial needs, objectives, methodology adopted, the benefits to the institution with the implementation of this system, the factors that led to the success of the project and its analysis. In section four, we present the results of the implementation of the IS to support the QMS in the Institution and in the fifth section we present the conclusions of our study. Finally, in section six it is listed the set of references used to develop the project.

2 QUALITY MANAGEMENT SYSTEMS STANDARDS (ISO 9001)

The standards oriented for the QMS certification in organizations, like ISO 9001 (Cianfrani, 2000), ISO 27000 (ISO 27000, 2009) bring numerous benefits for organizations because it is possible to define a set of information (procedural documents, forms, matrix activities, etc) that reflect the organizational activities of the various departments of an organization and achieve, in one hand, the compliance with the standards and in the other hand to establish flows to measure the quality of the services in order to improve their performance, efficiency and accuracy. ISO 9000 (Cianfrani, 2000) is a family of standards that specifies the QMS in organizations focused on the client satisfaction and the improvement of the services quality. This standard is based on eight quality management principles: customer focus; leadership; people involvement; process approach; approach to management through a system; continual improvement; approach to decision making based on facts; mutually beneficial relations with suppliers.

The ISO 9000 family is an extensive set of standard requirements, guidelines and other documents that provide a set of documental tools with which the organizations could manage and improve the quality of the services. These standards are characterized by the availability of a large volume of information that materializes the activities of the various departments of the organizations.

The task to control and manage the services performance by analyzing the KPI are typically made recurring to the analysis of the information obtained through the fill up of forms or by the other documents that need to be registered and stored. In terms of the ISO 9001 standard documentation it is characterized by the need of each process to have a process matrix (where are represented the general activities of the process and its participants and responsibilities, the used documents, the indicators for monitoring the service quality and the specification of improvement plans for each process in order to improve the quality services of the process), procedures and work instructions, the forms, the legal regulations, and other kind of information related to the processes (e.g. documents with the meetings decisions) and the notes associated with the processes occurrences (critics and suggestions). When there is a high number of the collaborators and when there is a high volume of information, the search
of the correct document to make a request or a procedure to execute a task is commonly difficult, especially when some tasks are not used with much frequency.

Additionally, the forms are characterized with many fields (necessary for the internal control and future analysis of the KPI) and difficult to fill up and to understand by the users when confronted with the necessity to submit information in a few set of fields of the forms. On other side, regularly, the top managers of the organizations (and especially the QMS managers) have to concentrate all the information of the different processes in order to analyze KPI to evaluate the services performance and to define actions to improve it. However, this simple task becomes difficult to implement, especially when the forms are filled out on paper or in digital format without being supported by any IS and are dispersed geographically.

Therefore, besides the advantages of the QMS to improve the quality of the services some difficulties are encountered in the usage of the documentation and in the concentration of the information to analyze the KPI.

2.1 The IPVC Quality Management System

The Viana do Castelo Polytechnic Institute (IPVC) (IPVC, 2009) is a High Public Portuguese Educational Institution and its organizational structure in integrated schools (Organic Units) oriented in the same mission, the geographical dispersion facilitating the relationship and sustainable development of the North region of Portugal given its size and proximity allows teachers and students develop personal relationships and professional training in education to improve the region.

The IPVC integrates seven organizational structures: five schools (Education School, Agricultural College, Technology and Management School, Management Sciences School, Health School), Social Services and Central Services.

The existing structure before the implementation of the QMS indicated differences in the way of how certain operations worked, especially those common to all schools. The knowledge of how each school did not always allow an overall management of the information available, requiring an increase in use of resources and unnecessary waste of time. There was a clear need to provide a team of employees in line with the central services of the IPVC to rethink the management model.

Several limitations and difficulties have been encountered in the implementation and use of the QMS as improving the qualifications of the care of administrative services in connection to a logic of proximity criteria with the rationalization of structures, the difficulty in integrating cross-administrative services and the provision of information, the difficulty of distance processes, the requirement and need for completion and circulation of documents in paper format for monitoring the progress of administrative procedures, the need to deliver documents in the presence of administrative services of schools, the existence of several dispersed information systems not integrated with each other, the difficulty of monitoring of the services, the use of documents in paper format to make the assessment of quality of service and the organizational culture and forces of change by employees.

Facing these problems the IPVC implemented a Quality Management System (QMS) (IPVC-QMS, 2009) that allowed to ensure the ISO 9000 certification (Cianfrani, 2000). The QMS covers the activities of the IPVC materialized in many processes (Academic, Environment, Health and Safety, Social Services, Courses Creation/Restructuration, Training, Economic-financial management, Management of works and Infrastructure, Information Management, Management and Improvement System, Project Management, Information Systems Management, Observatory, Promotion and Image, Human Resources and Technical and Educational Resources). In the context of this work the "Information Systems Management" Process (ISMP) was elaborated tends as base the COBIT (COBIT, 2007) considering the IT Governance concept (Holm, 2006) (Simonsson, 2008).

The COBIT (Control Objectives for Information and related Technology) (Ridley, 2004) (COBIT, 2007) (Sahibudin, 2008) developed by the IT Governance Institute in 1996 (ITIGI, 2009) with the ISACA –
Information Systems Audit and Control Association (ISACA, 2009) provides a framework that covers all activities of IT, such as control and security. The main focus of COBIT is the development of clear policies and good practices for IT security and control, or to both focuses on controlling the process and in strategic control of the organization. Its first aim is to develop the control objectives from the objectives and business needs. Is structured (COBIT, 2007) in three parts: i) criteria for Information (or business requirements): to meet the objectives of business, information needs to be in accordance with the criteria required of business requirements, requirements for quality (quality, cost, delivery), trust requirements (effectiveness and efficiency of operations, reliability of information, compliance with laws and regulations), security requirements (confidentiality, integrity, availability), ii) IT resources: resources are managed by the IT processes of IT to provide information that the organization needs to achieve its objectives. These resources include: applications, information, infrastructure and people), iii) procedures for IT: these cases bring together the main activities of IT in a model of process, facilitating the management of IT to meet the needs of the business. The processes of IT are defined and classified into 4 domains (Hussain, 2005), with 34 cases of IT. These processes will be presented and defined in activities and tasks in the organization.

3 THE IMPLEMENTATION OF AN IS TO SUPPORT THE QM SYSTEM

As we mentioned, the IPVC is a High Public School with an organizational structure integrated in administrative (and social) services and schools (organic units) dispersed geographically and implemented the QMS that enabled it to obtain ISO 9001 certification. However, all the documentation required by the standard was elaborated but many difficulties were found in the application of the large volume of the documentation as we mentioned in section two. Considering these problems, the implementation of an IS was vital for the success of the usage of the QMS. In this section we will present the need of the IS to support the QMS documentation, the requisites or functionalities of the IS (Russo, 2002) and the presentation of the project.

3.1 The need is the IS

The initial needs of the project (planning, developing and implementation of the IS) were: to improve the quality of care of administrative services in a combination of logic of proximity between students, staff, teachers and the external public IPVC; to resolve (or minimize) the difficulties of the QMS implementation and the use of the large volume of information; provide simple, fast and easy mechanisms to access to the information in order to select the correct documents to execute a task/request; provide automatic transmission of the requests between the users and the services; centralize requests made by users to allow the internal collaborators to define actions to reduce the execution time of the tasks to answer efficiently to the requests; facilitate the acquisition of information to determine the indicators for monitoring service levels. Additionally, other needs were identified: provide online the information for internal and external persons; provide services in order to articulate the three major dimensions (people, organization and technology) and promote the use of information technologies and organizational procedures and reduce costs and the use of paper.

3.2 Functionality throughout the IS

To design and develop the project we used the requirements of the methodology JAD - Joint Application Development (Wood, 1995). Analyzing the need of the IS to support the QMS we schedule two different phases in terms of functionalities developments. First, provide a set of functionalities to support the usage of the QMS and the quick access to the information to analyze the KPI. The second phase corresponds to the implementation of a workflow system to interconnect other IS within the organization. In this study we present the functionalities of the first phase because the second is actually in development. The functionalities of the IS in order to support the QMS were: the centralization of all information in an Web environment providing online access to all QMS information; provide indexing
items to access quickly to the correct document to perform a task/request; provide web forms for users to fill up only the necessary fields in the forms and then automatically generate the correct form according with the QMS specification; allow the automatic submission of the forms for the correct service (with a confirmation answer to the user); provide a task to schedule the services in order to analyze centrally the requests and provide internal actions to resolve with more efficiency the material and human resources and save time; provide automatic gathering of the information for KPI analysis; provide statistics of the KPI performance according to the objectives defined by the QMS; considering the different characteristics of the users the interface of the IS must me simple and easy to use.

3.3 The Information Systems

The IS modelling had into account the relationship between the three main dimensions of intervention (individuals, organization and technology). The planning of the system took into account the requirements of each process using the UML notation (UML, 2009) (Meilir, 1999). In terms of development, it was followed the guidelines of the PMBook (PMI, 2000) (PMBok, 2009). The architecture of the system is based on three layers scheme being separated the: interface layer (in PHP (PHP, 2009)), the business layer in PHP and the data layer in MySQL (mySQL, 2009).

Figure 3. Web Site to support the Quality Management System of the IPVC (IPVC-QMS, 2009).

In the figure 1 we present the main interface of the Intranet web site. It also offers a set of pages for public access from the Internet. On the left panel is shown a menu with all the processes involved in QMS and in which for each process is available the information about processes matrix, procedures and work instructions, the forms, data sheets occurrences and other important documents for the process. The users, when selecting an item (e.g., procedures), can analyse the most actual documents for the selected process. In the top pannel it is given a set of items related to the QMS like: mission, goals, strategy, processes managers, as well as audit plans, improvement plans, and all the organizational information of the QMS. On the right pannel are presented the news (e.g. change of forms, notices of use, etc.) in order to inform the users about the update of the information.
In order to achieve the functionalities mentioned in section 3.2 the figure 2 presents the information that allows the quick access to the documents to perform a task/request. For each department (left panel) it is provided (in the centre) a set of common items that users could quickly identify their needs. Selecting on item, the IS provide more information about examples of situations for the item, which is the correct document to use and the procedures that the user (and the services) will need to execute in order to be in compliance with the QMS.

**Figure 2.** Interface to provide quick access to the information of the QMS.

The users when proceed with the selection of the quick item to identify their need, the IS provide a web form (figure 3 (a)) to complete only the fields necessary to make the requests. Automatically the IS generates the correct form (figure 3 (b)) according to the QMS.

**Figure 3.** Web Form for quick fulfil of the requests (a) and automatic generation (b) of the documentation according with the QMS system.
When the user submits the form and generated automatically the QMS document, the IS sends an email for the user and for the respective services.

The services will receive the request (figure 4) and the collaborators of the different departments could analyze the requests list and schedule actions to resolve the problems. The figure 4 shows the interface for the control of the requests made by users. Each application is associated with a state of completion: treated (green), in treatment (yellow) and untreated (red). Each record is associated with a mode of editing that allows collaborators to characterize the request with internal information in order to be analyzed in the future and define strategies to improve the performance of the service in different types of requests. When the request is finished, the IS sends automatically an email for the requester to inform them about the state of their request or (if not treated) the state (or reason) with the justification for the facts.

Figure 4. Support system for receiving and processing requests from users.

The achievement of the indicators is one of the central points of QMS when it is possible to monitor and control the performance of the services by ensuring the timely application of measures to correct certain deviations less favorable in terms of performance.

As we presented, this IS is based on a management system database which allows (as the planning system) to get automatic performance indicators. Figure 5 illustrates the interface with the analysis of the monitoring of the performance for process Information Systems Management of the QMS.

This monitoring shall be submitted for each of the indicators defined in the state about the evolution over a given period. For each indicator there are associated two colors (red and green) to highlight the analysis of their value (not achieved and achieved respectively). Moreover, the developed IS allows the exploration of diverse information, such as the most frequent type of anomaly about information services required for the organic units (and other information) which could be analyzed by the departments responsible in order to define actions to improve performance in their department.
4 RESULTS

4.1 Benefits for the Institution

The developed IS project was called "Virtual Office" following a "Unique Attendance" logic and is operating for more than eight months. Although the IPVC QMS included various processes and information and the available forms and monitoring performances were initially considered for the "Academic" and "Management of Information Systems" processes. With the success of this IS in terms of best practice in Public Administration, the other QMS processes are actually covered with features developed and tested in pilot cases. For this, qualitative and quantitative benefits will be presented taking into account the activity of pilot cases (two QMS processes). However, the qualitative benefits include also all other processes regarding the provision of information, the availability of items for quick access to documents and the creation of online forms specific to the direct interaction between users and services (e.g. : Human Resources, Management and Improvement System). In this context the qualitative benefits were:

- Qualification improvement of the administrative services attendance;
- Reduced time to search and access to forms and to the correct procedures for the execution of a task or request;
- Reduced time to fill up the QMS forms;
- Immediate interaction between users and the services available 24 hours a day, 7 days a week, 365 days a year;
- Automatic obtention of the PKI for the services;
- Improved the interoperability between the various administrative services;
- Promotion of Information Technology for improving the treatment of procedural services.

The quantitative benefits were the:

- Reduced the use of paper in about 60%, since the forms began to be stored in digital format and supported by a management system database;
- Reduced the starting time for the implementation tasks since many collaborators receive alerts and can expedite the processes to realize to resolve the requests;
• Increase in about 60% of the use of Information Technologies by collaborators (teachers, staff and students) since they can make all their requests directly on the "Virtual Office" which also allows them to interact with other IS in the Institution (actually the academic services system for the launching of notes, or e-learning platform for consultation and update of content);

• Reduced by about 90% of the number of communication failures between departments and users, as the application submitted directly by the “Virtual Office” is registered in the database system, an email is sent to the user, the departments and the institutional manager of the process, allowing it to be recorded in different locations and monitored by several people;

4.2 Determinant factors for the success

The determinant factors for the success of the project were the availability of a tool with a friendly and appealing interface being also simple and structured to facilitate the usage and update of the QMS information; the availability of items for quick access to the correct forms and procedures for execution/request by users and collaborators; the availability of online forms with automatic generation of the QMS documents; the ability to monitor the requests to the services and streamlining of operations for processing requests; the direct taking of KPI; the interaction between services and users through automatic responses; the dematerialization of work processes allowing automatic execution of tasks that previously had to be carried out separately.

4.3 Monitoring the indicators

The IS is available since October 2008, and the monitoring of the indicators presented in this paper will be analyzed during this period. The indicators of the IS usage are centered in two lines:

• Implementation of a new service with greater value and efficiency: The IPVC Information Systems provide various units scattered by bodies which are not ensured of the availability of distributed and centralized QMS documentation. The IS provides a range of services that allow direct between users and services, enabling the completion of tasks faster and increasing the efficiency of administrative services;

• Improving the accessibility of the public service: the IS implementation, the various administrative services are available online 24 hours a day will improve the accessibility of citizens, since the communication is direct, avoiding the physical movement services;

Figure 6. Access by the different users.

Figure 6 presents the accessibility of public services to the system. The chart shows the distribution of access for the various users of the system (students, teachers and staff). The accessibility by the users to the systems is high, allowing us to conclude that this fact was possible because:
it became available on time the accurate information: all the information is available online for students, teachers and collaborators;

- has been identified the need to increase the overall satisfaction of the user: the IS was developed in order to increase the overall satisfaction of users and it was measured through satisfaction surveys;
- was a significant improvement of time to respond to user: through the centralization of applications requested, the IS enables the collaborators to schedule tasks and priorities for the implementation of the request in order to streamline the tasks, and so improve the response time;

With the implementation of the IS there was:

- Reduction of costs by the users to access the service: as the IS is accessible anywhere and at any time, travel costs to the various organic units for the delivery of documents is avoided, as well as online communication with the services are directly allowing clarifications made no additional cost. Moreover, the digital information can save the cost spent on paper;
- Reduction of operating costs: the use of the IS allows employees to communicate with the various administrative services, streamline tasks to reduce the task execution time, reducing the cost of communications between services, reduce costs with the storage space;
- Improvement in quality of service: with the implementation of the QMS and the IS enabled the faster expedite requests for support from users,
- Increased number of customers (students, staff and teachers) and there was an increase in the use of the services: The number of customers/users that access to the IS is presented in Figure 7.

In the figure 7 we can analyze some reduction in the number of the accesses between December and July. The justification for this fact is that, in the IPVC the middle class teaching is from the 15th of December and January tends to decrease due to the school calendar and national holidays. In this context, the system accessibility should be analyzed in two periods: October to November (inclusive) and December to January. In the period October to November is the activity more intense services and teaching activity. As we analyze there are an increasing number of users to the main administrative services. However, the average access focuses on more than 1,100 accesses per month.

![Accessibility to the Information System](image)

**Figure 7. Accessibility of the Information System implemented**

Additionally KPI indicators were analyzed in terms of the Information Management QMS process and Academic Process like: Number of requests for support from its users caused by inadequate training, Number of annual events by the application of software for servers that caused losses of operation, Average time (days) in response to the recovery of the component of the technological infrastructure without purchasing components, rate of incidents that require support in place (outside the Information Technology Services) of the occurrence, rate of incidents resolved and finalized the responsibility of Information Technology Services, rate of incidents reopened, rate of backups of critical data (defined by the policy of backups), rate of successful tests of the backups of the data from Information Systems.
We also monitored the satisfaction levels and formation associated with the clients/users of this process (ex: % of users satisfied with functionality delivered, training days per IT employee per year related to compliance, % of board members trained in or having experience with IT governance, level of training attendance of users and operators for each application, % of stakeholders satisfied with data integrity of new systems, etc) but are processed and analyzed in the IPVQMS "observatory" process. The same treatment is done for the IT suppliers (ex: % of major suppliers subject to monitoring, Level of business satisfaction with effectiveness of communication from the supplier, # of formal disputes with suppliers, etc).

4.4 Implementation challenges

The implementation challenges of the IS were focused on the ensurance of the requirements of: providing to the users a simple interface to use and all the information about the documents of the ISO 9001 standard; availability of items for quick access to information; provision of forms to complete fastly; obtain automatic indicators about the services performance. Development process of the IS was focused initially on the analysis of the diagnostic requirements and the profiles of the various types of users. The development process of the application took about two months. After the development phase, the prototype system was tested during three months. However, during this phase of usage, it was necessary to provide rapid access to the services, provide forms with a quick fill (figure 3) and also all the QMS information or documentation. Before the development of the IS, the documentation of the QMS was released on an e-learning platform (Moodle, 2009) that only offered a set of folders where the QMS documents were stored. The structure of that system (in directories) caused a set of difficulties; the information given was a set of documents with the actual and the old documents of the QMS processes; it doesn’t give a flexible way to get quick access to the information and doesn’t provide the automatic obtention of the QMS processes’ indicators. In this sense, the challenge that the development team found was the need to implement, as soon as possible, an IS with the above requirements and to ensure the IT Governance concepts. The main challenges for the team in terms of development were the focus on the specification and the availability of an interface easy to use, where in the past a large majority of users felt a great difficulty using and upgrading to new technologies and the development and availability of an IS with a workflow engine (Sharp, 2001) in a short time period.

5 CONCLUSION

The guidelines of the quality management systems standards (in especial the ISO 9001) bring huge benefits in terms documents definition with the flow and correct specifications to support the various activities in the organizations focused on the quality of the services and the customers satisfaction. However, despite these advantages of the applicability of these standards, there are several difficulties in terms of implementation as well as the difficulty in providing the information in a distributed way, the difficulty to access quickly to the correct procedures and forms to execute a particular task, limitation to monitor the services’ performance to concentrate all the information, the difficulty to obtain the data for evaluation of the Key Performance Indicators, among others. The Viana do Castelo Polytechnic Institute implemented the quality certification of its services through ISO 9001 standard and has developed an Information System to support it. If the system was not developed, the implementation of the Quality Management System would not be successful, because although the information can be stored in a set of directories, there’s no quick index of research, there’s no automatic generation of the forms, there are difficulties to obtain immediate indicators of management and the operating costs are still high. Additionally, the implementation of this Information System enabled the articulation between the three main dimensions of intervention (individuals, organization and technology) in terms of the use or in terms of ensuring the availability according to the requirements of the standard. The implementation of this Information System can be characterized as a good practice for the use of Information Systems in Public Administration, as to: implement a new service with greater value and efficiency, to improve the accessibility of government services to citizens, providing citizens with
accurate information in time, significantly improve the response times of the citizens, reduce costs for citizens in accessing the service, reduce operational costs and improve quality of service provided.

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