Development of a web system for the management of PQRS in higher education institutions

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Abstract. The acquisition or development of a software in a company must always obey to meet a specific need, either to carry out a process in a better way or as an added value to a process that is currently managed efficiently. Such is the case of the web system for the management of requests, complaints, claims and suggestions (PQRS) of the Antonio de Arévalo University Foundation - Unitecnar, which emerges as a technological tool to systematize and optimize the current process of registration, consultation, management and monitoring PQRS. The article below details the development methodology implemented that for this case was the agile XP methodology, which allows iterative development, teamwork, and delivery in the shortest possible time. On the other hand, the technological tools used are described, which were: the CodeIgniter framework for application development in PHP, the Bootstrap framework for the creation of responsive web pages and PostgreSQL as a database management system. Finally, the results obtained that consist of two web applications will be explained. One to register, consult and evaluate PQRS. And the other is the tool through which the administration, configuration and monitoring of the PQRS is carried out.

1. Introduction

Technologies in recent times have had a vertiginous boom in all areas of society, and this includes organizations. We see today, how they are being integrated into companies through innovative computer systems. Therefore, its implementation is no longer a luxury or an investment but a fundamental need that allows large and small companies to be at the forefront of new times, with competitive processes both in the national and international market [1].

The acquisition or development of an information system in a company must always obey to meet a specific need, either to carry out a process in a better way or as an added value to a process that is currently managed efficiently.

On the other hand, the contribution that information systems have provided to companies today has been very important, which is why they are considered as one of the most relevant components of the current business environment, which offer great opportunities for success for companies, since they have the ability to collect, process, distribute and share data in a timely and integrated manner. In addition, they help narrow geographic gaps, allowing employees to be more efficient, which is reflected in an improvement of processes, management, and information management, resulting in a positive impact on productivity and competitiveness of the companies [2].
Additionally, the Internet, specifically the WEB, has become the means not only to disseminate information but also as a tool through which companies can carry out tasks or execute operations, with the ease of being able to be carried out from anywhere in the world. This is why computer-based information systems, particularly after the exponential relevance acquired by the web and the internet, have had a profound impact on how organizations, economies and societies in general carry out their activities. [3]

The use of technologies and information systems by organizations is indifferent to the sector to which they belong. This was evidenced in a recent study carried out by the company Fast Company in which it is stated that the most innovative companies are those found in the education sector [4]. This study clearly demonstrates that organizations dedicated to the education sector are increasingly involving information systems for the management of their academic and administrative processes, since having solid and reliable information systems contribute to the transformation and modernization of the sector [5].

All of the above has led the Antonio de Arévalo University Foundation - Unitecnar, making use of the internet and its institutional web platform - which generated competitive advantages in the market - to develop a web system to register, consult, evaluate and respond to requests, complaints, claims and suggestions made.

The purpose of this article is to show the results of the system developed and implemented for the management of PQRS, explaining the development methodology that for this case was XP, the use of the Codeigniter PHP and Bootstrap framework and the database managed with PostgreSQL.

2. Case study description

The Antonio de Arévalo University Foundation - Unitecnar is a higher education institution with headquarters in three of the main cities of Colombia, such as: Cartagena de Indias, Barranquilla and Santa Marta. This institution has established as a quality policy the continuous improvement in its academic and administrative processes, being the PQRS a tool to know the different concerns and situations that affect the users and interest groups that have some relationship with the institution.

The institution, in its quality management system, has a procedure to assess student satisfaction and a format for the registration and attention of PQRS. The only channel for the management of PQRS was email and its procedure was as follows:

- If a user had any request to submit, they should fill out and send the form by email to the Institutional Welfare Department (area in charge of this management).
- The Institutional Welfare Directorate, in turn, evaluated the case presented and sent it to the area responsible for providing a solution.
- The area in charge then performed the requested procedure. And the process ended by sending a message by email with the response to what was requested by the user.

As you can see, all the management of requests, complaints, claims and suggestions described above, was done through emails; thus becoming a slow and tedious process. Considering the need to improve the process, it is decided by the development of an information system. This system, on the one hand, should allow the registration, consultation and evaluation of the PQRS. And on the other hand, it should allow the administration of registered PQRS, respond to requests, observe the traceability of a specific PQRQS, consult user evaluations and generate reports for decision making.

3. Methodology

3.1. Agile XP methodology

There are different methodologies that can be applied in the field of software development, which detail the activities and processes to follow in the execution of projects of this type.

At present, the use of agile methodologies that are characterized by iterative and incremental development, frequent deliveries and simplicity of implementation has been imposed; prioritize requirements, continuous communication with the client and cooperation between developers [6]. It
should be noted that the increasing use of this type of methodologies is due to the fact that they are the most appropriate in projects with system environments is very changing, and where it is required to drastically reduce development times, while maintaining high quality [7]. As was the case in Unitecnar, which required a customized information system and quality in the shortest possible time, to manage everything related to PQRS, so it is decided by the XP methodology (Extreme Programming). This methodology evidences principles such as incremental development, active customer participation, accepting change and simplicity [8].

The client requirements were defined through user stories, which is a technique to specify the software requirements [9]. Each story was described by the client in a simple language and with the help of the developers they are assigned a priority, estimating the time for its development [10].

Figure 1 shows the main user stories that make up the system.

| No.  | User stories                                                                 | Priority (1-min / 5-max) | Estimated time (days) |
|------|------------------------------------------------------------------------------|--------------------------|-----------------------|
| 1    | PQRS management areas.                                                       | 2                        | 3                     |
| 2    | Types of PQRS, with their response times and transfers.                      | 2                        | 3                     |
| 3    | Registration of non-work days by headquarters.                               | 2                        | 2                     |
| 4    | Form to register a PQRS, including the different situations that may arise (sending mail) | 5                        | 10                    |
| 5    | PQRS consultation by an applicant. In addition you can evaluate the response received | 4                        | 5                     |
| 6    | PQRS administration.                                                         | 4                        | 7                     |
| 7    | PQRS management by the person in charge of an area (write draft, finalize PQRS, transfer, mail delivery). | 5                        | 12                    |

**Figure 1.** User stories.

Subsequently, a series of deliveries or iterations defined between the client and the developers were established to develop a group of stories. You can create or modify stories at any time. Each delivery includes a new useful functionality within the system, which after being developed, is integrated, tested and evaluated to finish the cycle and then start with a new one, as seen in figure 2. Finally, when there are no more Cycles to execute, it is understood that the system has been fully developed.

**Figure 2.** Delivery cycle in Extreme Programming. [8]

The lifecycle of this methodology is composed of the following phases:

3.1.1. **Exploration phase:** In this phase, the scope of the project was defined based on user stories. For this project, a time of 4 months was estimated. In addition, in this phase the developers became familiar with the technological tools that they would use in the project.
3.1.2. Planning Phase. User stories were prioritized, estimating the time that would be used for their development. In general, a work schedule was established, specifying four (4) iterations, each with its delivery times. Particularly, in this phase the stories that were part of the first installment were chosen.

3.1.3. Iterations Phase. Deliveries were executed, developing and testing the functionalities. As the project progresses, the client can add new stories, modify existing ones or even eliminate specific ones, so developers should adjust their next iterations. At the end of this phase the system is now ready to take to production.

3.1.4. Production Phase. In this phase, the system was enabled for operation and the new improvements that emerged were added to new iterations.

3.1.5. Project Death Phase. When there were no more iterations to perform, this phase has been reached, in which the system is documented, generating the different manuals necessary for the correct use of the system.

4. Technological tools for development
A non-functional requirement of the system is that it could be integrated into the institutional application platform called SIA (Integrated Application System), therefore, web technologies should be used, with the interaction of a database and free tools. Therefore, the technological tools used were:

4.1. Framework CodeIgniter
It is a framework for developing web applications in PHP, which allows the creation of applications quickly due to the set of libraries that it presents for common tasks, as well as a simple interface and a logical structure to access those libraries [11, 12]. The version that was used in this project was CodeIgniter 3.1.9, downloadable from its website, obtaining a folder structure that should be configured and adapted to the project to be developed, as shown in figure 3.

Figure 3. Project folder structure.
4.2. Database with PostgreSQL
It is an open source relational database management system [13], which offers features such as: different and very specific types of data, triggers, functions, views, etc. The version used was PostgreSQL 9.3.

4.3. Bootstrap
It is a library or set of open source tools for web application design, which includes design templates based on HTML and CSS for typography, forms and many others, as well as JavaScript add-ons, etc. [14]. Bootstrap allows you to create responsive, fast and simple web pages.

5. Results

5.1. Structure of the system database
The system has a structure of related tables as shown in figure 4. Likewise, triggers were developed for the execution of certain processes and views to generate queries with several tables, this in order to assign a certain workload to the base of data, thus saving lines of code and execution of processes on project pages.

![Figure 4. Table structure.](image)

5.2. Description of the System developed
The system is fully responsive and easy to use, consisting of two web applications. One to register, consult and evaluate a PQRS. The other to carry out all administration, configuration, response and monitoring of the PQRS.

The stages of the process that are executed through the system are:
- Registration of a PQRS by the user.
- PQRS consultation by the area manager.
- Transfer to another area.
- Answer PQRS. When an answer is given, a message is sent to the request user.
- Consult a PQRS by the user.
- Evaluation of a PQRS by the user.
- Monitoring and reports.
5.2.1. Application for registration, consultation and evaluation of PQRS: This tool allows any user with access to the Web to make a request, complaint, claim or suggestion to the institution. The application is accessed through the URL (http://appz.unitecnar.edu.co/pqrs/), which will load a page like the one shown in figure 5-A. In addition, it has the options to consult the data of an already registered PQRS (see figure 5-B) and observe the response that has been received and finally evaluate it.

![Application for registration, consultation and evaluation of PQRS](image_url)

**Figure 5.** Application for registration, consultation and evaluation of PQRS. A) Main page. B) Form to file a PQRS.
5.2.2. Application for administration, configuration, response and monitoring of PQRS: This application is integrated into the institutional application platform - SIA. Only users authorized by the institution can enter (see figure 6), and have access to the options that are enabled.

The user profiles that were defined for this system are: **Administrator** and **area managers**. Based on user stories and system design, **Administrators** can:

- Configure the locations that will handle PQRS.
- Configure the types of PQRS, defining response and transfer times.
- Configure non-work days by headquarters, as shown in Figure 7-A.
- Consult all PQRS, observing response times, delays (see figure 7-B).
- Transfer a PQRS to another area.
- Generate reports and download them in format for Excel and PDF.

**Area managers** are responsible for responding to a PQRS request. The options it handles are:

- Consult PQRS of the area.
- Give answer. The system allows saving a draft of it.
- Transfer a PQRS to another area, as long as it is on time.

5.3. **Benefits of system implementation**

The benefits that have been obtained are:

- More efficient management of the data, generating greater control and security in its management.
- Agile and secure access to information, with a tool that facilitates searches and report generation.
- Use of the system at any time and from any place since it was developed oriented to the web.
- Reduction of institutional costs in human talent, physical infrastructure, time spent in the execution of procedures and / or manual tasks, etc.
- Have a computer tool tailored to institutional needs.
Figure 7. Application for administration, configuration, response and monitoring of PQRS. A) Management of non-work days by headquarters. B) Consult all PQRS.

6. Conclusions
Integrating technologies into the execution of activities carried out in organizations will always be of great benefit, contributing to the optimization of their processes, resulting in much more efficient management, reducing organizational costs, among others.

The implemented web system has allowed the community in general to have better communication channels to express their concerns and suggestions. On the other hand, the institution currently has a tool through which it obtains first-hand information on those situations that afflict users, in order to execute actions that allow improving processes, guaranteeing a better service and improving levels of satisfaction.

According to how the system was designed and developed, its implementation can be extended to other types of organizations, since it has the basic functionalities necessary to manage PQRS processes.

Conflict of Interest.
The authors report there are no conflicts of interest.

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