Management Technology for Institutional Environment in Pandemic Times

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Abstract. Regarding the current social state and the benefits of social distancing, this paper intends to use technology, namely mobile and web applications, to control the flow of people in institutional spaces, namely the management of students at Polytechnic Institute of Viseu. The idea is to use QR codes distributed in spaces (classrooms, libraries) so that it is possible to carry out monitoring in real-time. When a professor or student attends a specific room, information about the number of people in that location will be updated in the app. Thus, it will be possible to count the number of students present in each space and carry out the automatic registration of students' attendance per class, removing the professor's concern about registering them. The application will also be able to effectively control the sanitation of each space since alerts will be issued at the end of each class to the administrator of the web application. As for the web part, the responsible institution will be able to make the schedules of the different shifts available to students via the website to enroll in these shifts and access information regarding the number of people who intend to attend a specific class. In this way, it will possibly be better to manage academic sites in terms of social distance.

Keywords: Management · Academic environment · Social distancing

1 Introduction

A technological project is being held at the Polytechnic Institute of Viseu [35] to contribute to the current social situation in Portugal [8], with the help of professors, aimed at the development of a mobile and web application that results in an optimized administration of classes and internal spaces inside an academic institution [14].

In this way, the system works to facilitate access to the acquisition of information by the student regarding the number of people present in a specific room during a class

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and giving the professor the possibility of getting feedback from the students about their courses as well, where they will be able to evaluate 1 to 5 stars [22]. A QR code is a two-dimensional symbol invented in 1994 by Denso [12]. One of the primary group companies, i.e., Toyota counts the number of people [27]. QR codes can support higher data density and can be used free of charge, making them a perfect choice for the project [20].

The study's primary purpose is to allow a student to perform the scan available physically at the university classroom door. In this way, their entry will be counted in the database, making this information available to the administrator, professor, and other students, all related to the class.

Likewise, at the end of the class, the student will scan the QR code from inside the room. The professor will have the option to end the lesson, receiving a list of attendance with the names and numbers of each student present. The university manager will administer the web, where he will have options to insert students and professors, remove them, manage disinfection alerts for places after classes and keep track of general data.

The development of this management tool arose, intending to return to the universities' classroom classes, it is possible to manage the number of students in specific classrooms during certain courses [6]. Thus, it facilitates the teacher's registration of presences and gives information on the number of students present in a room.

2 Background

As we know it today, the Internet was started as a military project between the 1960s and 1970s to share information between the bases in a safe way [1]. In this sense, Velloso [32] brings the definition of the Internet that nowadays is employed as the most prominent electronic communication network, operating in all parts of the world in millions of computers.

Over time, the Internet underwent significant changes until it reached its commercial use in the mid-1990s [33]. The same, which was previously private to the United States of America citizens, was disseminated in other countries, similarly entering society to electricity at the end of the 19th century [28].

We live in the so-called "information age", where we are updated concerning the latest events worldwide and almost instantaneously, thanks to the Internet, which enables socialization and communication between people from different places of the world [10, 30].

Then, it is perceived that the Internet is increasingly present in a globalized context [18]. Its presence is even more on the agenda in the current social and economic scenario that we find during the period of isolation, the result of the pandemic caused by the virus SARS-CoV-2 discovered in 2019 in China, Wuhan, causing instant lockdown by the authorities and thousands of deaths [7, 31].

The discovery of this new type of virus has brought a turnaround in the way we organize ourselves. Different areas, such as education and business institutions, have had to, more than ever, resort to the Internet, migrating all their activities to online platforms [21].

Regarding the transition of schools and universities, they had to abruptly organize themselves to find a way to migrate their entire teaching and learning system to be condensed into classes held using electronic devices [23]. Online learning is nothing but the use of the Internet applied to educational purposes [29].

In this way, students at all levels of education were also affected by the rapid change in teaching standards known as "remote learning" [16]. As a result, they will not complete their school curriculum and assessment in the usual way, and, in many cases, they have been torn away from their social group almost overnight [9].

Indeed, the transition from conventional teaching methods to online methods has pros and cons [11]. On the one hand, it causes the lack of contact between instructor and student that, for some students, can be crucial due to lack of attention and concentration in classes [11]. Because it depends entirely on electronic devices and the Internet, online learning can jeopardize both teachers and students who have a bad Internet connection or out-of-date devices [34]. On the other hand, online classes promote studies in environments more conducive to student comfort, which can be seen as a disadvantage or advantage [15]. In addition, it is providing a safer environment because we do not have to physically move to attend classes, reducing the risk of contamination of the virus [17].

Also, as expected, not all universities and schools could, both financially and technologically, migrate their education and learning systems to online platforms [24]. In this way, many students worldwide, more specifically in underdeveloped countries, while was directly impacted by lockdown and rapid lifestyle change, have been jeopardized for months without access to classes, whether face-to-face or online [13]. Consequently, they will graduate after an extended period, in addition to future challenges in the labor market, as Sahu states that the graduates are going to face the severe recession of the global recession caused by the COVID-19 crisis [4].

It is, in fact, an overwhelming situation, because on the one hand, online learning is currently saving us during this pandemic period [5]. On the other hand, however, there are still universities and educational institutions that need face-to-face access to education due to the financial conditions of the institution and students [3].

3 Materials and Methods

3.1 Requirement Analysis

Requirement analysis is an essential aspect of project management, as it aims to document the steps that the software will perform. It consists of recognizing and evaluating the problem, deconstructing it into smaller parts, modeling data, and consolidating functions and interfaces.

When applied to software development, this step can predict the behavior of the system, including any unexpected problems, as it also makes it easier to add new features to a project already under development, meaning less investment and human resources.

It is noteworthy that the requirements are fundamental for modeling, design, implementation, testing, and maintainability, as they are separated into two main aspects: functional and non-functional requirements.

3.2 Functional Requirements

According to Ruth Malan, functional requirements describe what the system does or does not do by defining services and tasks. That is, all the needs, features, and functionalities are expected in a process that the software can meet. Functional requirements, in short, refers to what the system must do, and as they cannot be measured, they are specific actions or behaviors of the system [19].

Regarding the mobile app, it will be developed so that professors and students can access it. This way, it will be divided into two parts: the students and the professors. For the functional requirements of the mobile app, Table 1 describes the most relevant ones.

Table 1. Functional requirements (student perspective app)

#	Description for the app - student	Priority
1	It should be possible for the user to request a reset of their password, informing the e-mail address	HIGH
2	The system must provide a list of upcoming classes for the user	HIGH
3	The system only accepts users belonging to the email list registered by the administrator	HIGH
4	The user should see information about the class such as professor, date, time, place, other students' class rate, subject, and description	HIGH
5	The user should have access to exercises related to a specific class	HIGH
6	The system should allow the student to rate a professor's class from 1 to 5 stars	HIGH
7	The system must allow edit user data, such as name, email, and photo	MEDIUM
8	The system should display information about the number of classes taken, graphics about performance, etc	MEDIUM
9	The system must allow the user to access other user profiles	LOW

Regarding the user from the perspective of the professor, Table 2 demonstrates the most important of them.

The web application will be aimed at the university administrator to add files regarding the classes, students, professors, and classrooms. When it comes to its functional requirements, those can be found in Table 3.

3.3 Mobile App

The mobile application development is being carried out in the modern Dart programming language, developed by Google. According to [18], Dart is a general-purpose programming language designed with ease of use, familiarity to most programmers, and scalability in mind. Along with this powerful language, the Flutter framework is also being used, which allows the rapid and scalable development of mobile and web applications. Minetto explains a framework as a 'basis' from which one can develop

Table 2. Functional requirements (professor app perspective)

#	Description for the app - professor	Priority
1	It should be possible for the user to request a reset of their password, informing the e-mail address	HIGH
2	The system only accepts users belonging to the email list registered by the administrator	HIGH
3	The system must provide a list of upcoming classes for the user	HIGH
4	The user should be able to add and edit the description of the class	HIGH
5	The system must allow the user to attach exercise files to classes	HIGH
6	The system must allow the user to initiate and end classes	HIGH
7	The system must allow the user to export files containing information about the class attendance list	HIGH
8	The user should be able to publish announcements in the community area	MEDIUM

Table 3. Functional requirements of web application

#	Description for the web – university administrator	Priority
1	The system should allow registering of new users, performing the validation via a confirmation email	HIGH
2	It should be possible for the user to request a reset of their password, informing the e-mail address	HIGH
3	The user must be able to add new places that belong to the university	HIGH
4	The user must be able to add new users and classes	HIGH
5	The system must alert the administrator if a classroom is highly busy with an urgent disinfection alert	MEDIUM
6	The system must show statistics about the university (number of app users, number of internal places, etc.)	MEDIUM
7	The system must allow edit user data, such as name, email, and photo	LOW

something more significant or more specific. It collects source codes, classes, functions, techniques, and methodologies that facilitate the new software development [17].

One of the advantages of using a framework is automating tasks through internal operations that prevent unnecessary code repetition. Therefore, the Flutter framework was chosen because it is a robust, time-saving framework with multiple features that can build and maintain quality mobile applications. Figures 1, 2, 3 and 4 show the prototype developed so far regarding the student part of the application.

Fig. 1. The initial screen of the app with login buttons for the professor and student

Fig. 2. Student login screen

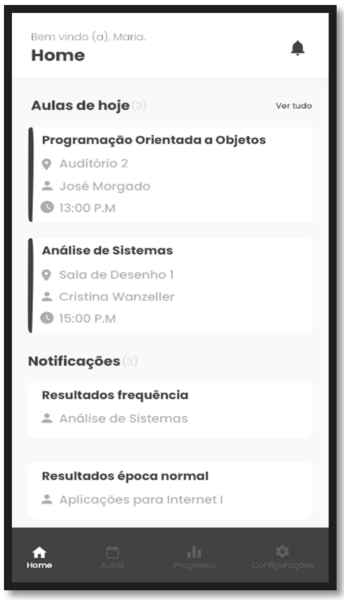

Fig. 3. Home page with upcoming classes and notifications

Fig. 4. Information about a class

3.4 Web Application

Regarding web pages that are available to the administrator, the front-end is being implemented using the HTML markup language, created in 1991, and the CSS style sheets, the latter being optimized using the Bootstrap framework. The language is limited and has only the function of pointing out what information should appear in the browser [4]. When talking about HTML, it is also necessary to quote a language for styles and definitions of the layout of HTML documents. In this context, there are cascading style sheets (CSS). Cascading style sheets change the way pages are organized. The user can set in a single location the formatting used by each tag [22]. CSS is a formatting mechanism, such as color insertion, fonts, spacings, among other needs, all for better interaction with the user.

Since there is a need for data storage, it is necessary to use a Database Manager System that is defined as a general-purpose software system that facilitates defining, building, manipulating, and sharing databases between multiple users and applications [28]. In other words, they are software that provides the user with the ability to guarantee and manage the integrity of the data and create and store them. For the creation of the application design, the Adobe XD the program, designated for prototyping and design, was used. Figures 5, 6 and 7 present the prototypes developed in Adobe XD for the web application.

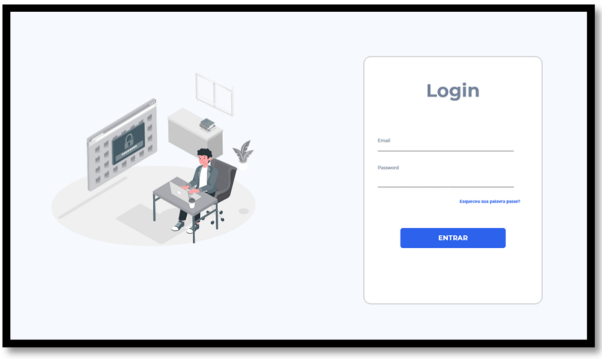

Fig. 5. Login screen for the administrator

3.5 Survey Questionnaire

A survey was applied as a questionnaire to validate the problems found in the hypotheses raised during the project. Thus, two surveys were developed to conduct the research, which, as explained in [26], collects data from a series of pre-elaborated questions. In total, 27 professors and 52 students from the Polytechnic Institute of Viseu were interviewed. Some were having and teaching online and in-person classes when this survey was developed and tested, while others were only having online courses, as the results show.

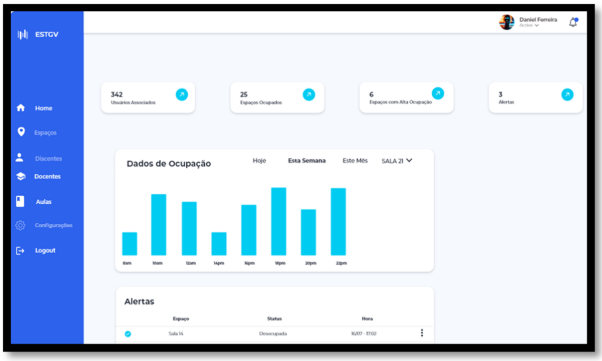

Fig. 6. Dashboard

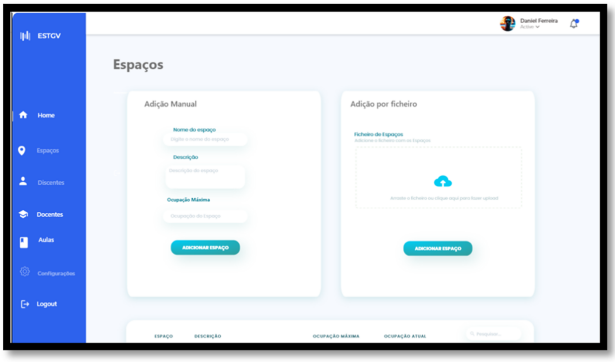

Fig. 7. Add new spaces to a university page

These surveys were developed for two future users of the mobile application: students and professors. The questions were designed to understand better how people are dealing with online learning and teaching and if they would find it acceptable to return to in-person classes if better management of the number of people took place. The results are described in Figs. 8, 9, 10, 11, 12 and 13.

As shown in Fig. 8, most teachers are still taking classes online, with a percentage of 88.9% in the "yes" answer. Next, as shown in Fig. 9, most teachers want to know the opinion of the students about the classes. Thus, one of the features designed to be implemented in the project's mobile application is the possibility of rating a professor's class out of 5 stars. Finally, as shown in Fig. 10, the professor likes the idea of automation in obtaining the attendance list.

Next, the questionnaires applied to the different students were analyzed, verifying that 69.2% of respondents develop more excellent content retention when participating physically and personally in the teaching process. In comparison, only 17.3% of students prefer the online methodology, as shown in Fig. 11. Furthermore, as presented in Fig. 12, 65.4% of students would like the possibility to evaluate a teacher's class. Finally, Fig. 13 shows that 61.2% of the students interviewed responded positively to whether they would

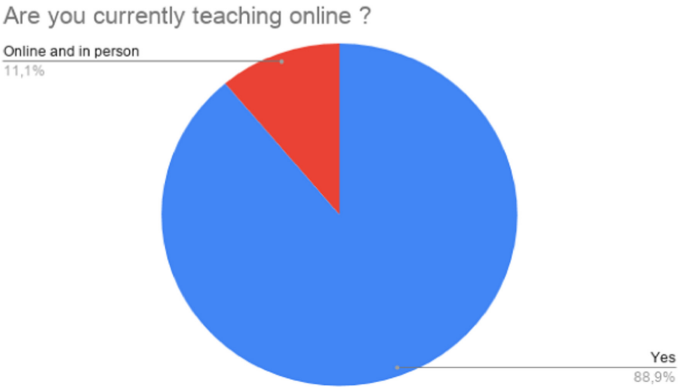

Fig. 8. Answers to the question "Are you currently teaching online?"

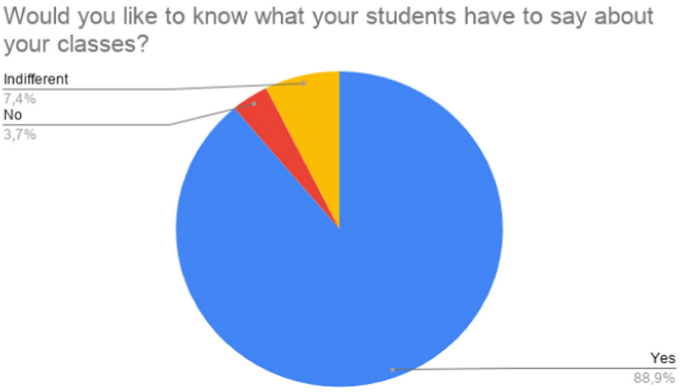

Fig. 9. Answers to the question "Would you like to know what your students have to say about your classes?"

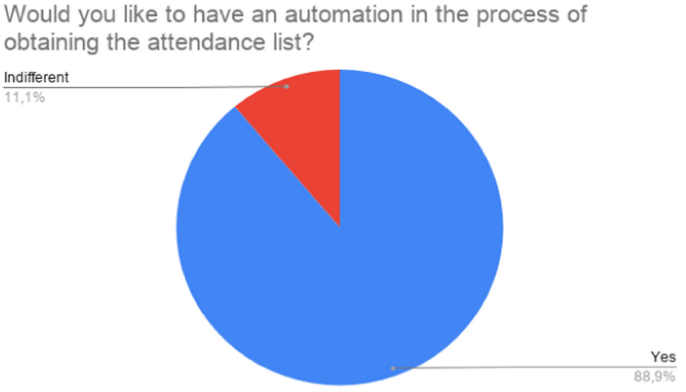

Fig. 10. Answers to the question "Would you like to have automation in the process of obtaining the attendance list?"

feel safer and more comfortable if there were better management of the number of people within a classroom.

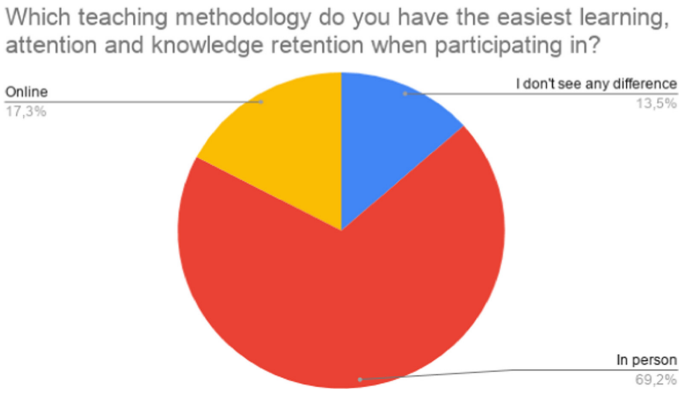

Fig. 11. Answers to the question "Which teaching methodology do you have the easiest learning, attention, and knowledge retention when participating in?"

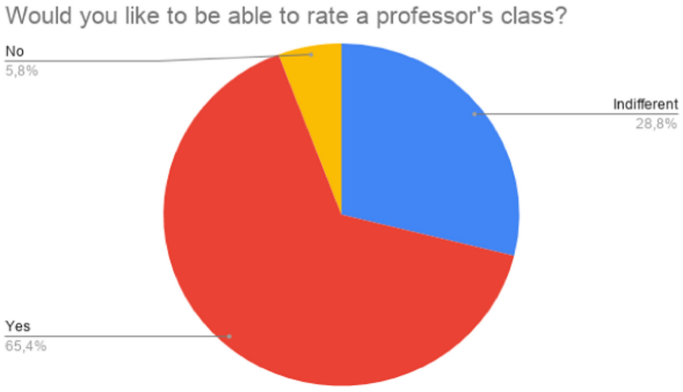

Fig. 12. Answers to the question "Would you like to be able to rate a professor's class?"

Through this short survey, it was found that the data presented in the charts both students and teachers are willing to test new technologies regarding the best student-professor relationship in the educational field, and mainly some relevant points were noted for the construction of the solution.

Initially, the survey of the functional and non-functional requirements of the system was distributed. According to [25], non-functional requirements, unlike functional ones, do not express any function performed by the software but rather behaviors and restrictions that this software must satisfy. Thus, it is a software engineering step in which development paradigms are constructed from the functionalities that the system must perform.

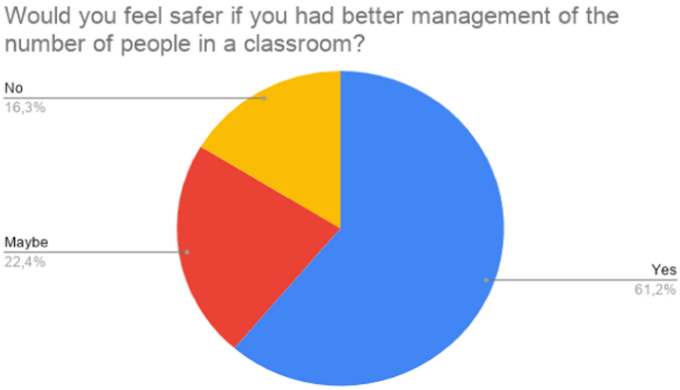

Fig. 13. Answers to the question "Would you feel safer if you had a better management of the number of people in a classroom?"

Among the functional requirements, the following stand out: evaluation of teachers, feedback of classes by students, registration of places in the institution by the administrator, among others.

3.6 Use Case Diagram

In system analysis, a use case diagram helps the team understand how a user might interact with the system that is being engineered. Ivar Jacobson designed this diagram in 1986. It consists of a methodology that can also be used outside software engineering with a few adjustments and helps identify all system requirements [2].

There are four main components in a Use Case Diagram: actors (1): the users who interact with the system. The actor can be an external person, organization, or system that interacts with your application or system. However, they must be external objects that produce or consume data. (2) System: a specific sequence of actions and interactions between the actors and the system. The system can also be called a scenario. (3) Goals: the result of most use cases. A correctly created diagram should describe the activities and variants used to achieve the goal. (4) Use case: horizontal oval shape and representing the different uses that a user can have. (5) Associations: a line between actors and use cases. In complex diagrams, it is essential to know which actors are associated with which use cases.

In Fig. 14, there is a simple use case diagram to illustrate the system overview.

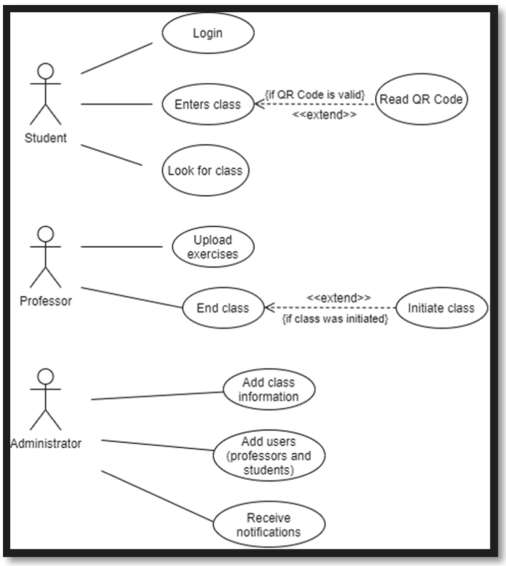

Fig. 14. Use case diagram for overall system

4 Discussion and Conclusions

It is undeniable how fast every aspect of living changed after the world breakout in 2020, including teaching methods. Yet, until this day, every time a school or university tries to open doors, it immediately shuts down after a few days, commonly because of the virus outbreak.

Given this issue, there is a need to manage university institutions and the use of technological applications to do so, thus ensuring the security conditions to minimize the contagious caused by SARS-CoV-2 in these environments. Therefore, we aim to make it possible, enabling the use of digital presences and functionalities that allow the student to give feedback on the classes attended, increasing the proximity between professors and students.

After the data, we could gather it by carrying out the survey. We could state that both professors and students are open-minded about the application we intend to develop. For example, informing the users of the number of people present in a room will be beneficial to the administrators to create a greater sense of space and disposition of students in a classroom. In addition to giving the professor automation in obtaining the attendance list of a particular student in their class to improve his didactics based on the feedback that his students will provide on the platform, to improve their teaching techniques.

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