ABSTRACT
There are multiple commercial eHealth platforms and research projects working in this type of system, but only some of them take into account patients’ interaction. This paper presents an approach of eHealth system based on user centered design. To achieve a user centered design system, a multidisciplinary development team has been cooperated. The proposed system permits the communication between doctor and patient with chronic diseases through the information exchange in a simple and efficient way. With this system we can analyse the important of the feedback provided to the patient and follow her/his evolution online detecting deviations faster than with the traditional health systems. The system has been tested by doctors and patients with different chronic diseases, and objectives and subjective results—obtained by surveys—are promising.

KEY WORDS
User centered design, chronic disease, eHealth system

1. Introduction

In recent years, new technologies are being incorporated into health systems and different applications are being developed aimed at professional help when it comes to keep control of their chronic patients [1].

The literature contains numerous investigations the researchers are doing on eHealth systems across Europe [2]. These types of systems are very useful, such as the European Project epSOS [3-5], which allows the consultation of the medical patient record in the European cities that are participating in the project. With epSOS, the doctors have access to relevant patient medical data, access to electronic prescriptions and patient access to medical information. Other existing projects are GNUHealth [6] or the Dossia [7]. GNUHealth is a system for hospital management and health information, through which the doctors access the electronic medical record.

Dossia is a web platform which provides users with personal information so they can keep control of their health and care.

This type of system is adapted for different users such as physicians, patients with chronic diseases [1, 8] or for the elderly, and it provides customized monitoring, alerting services and assistance [9].

Although all the systems mentioned allow users to see her/his health information or records, there is still a need of a simple and optimal basis for communication between doctors and patients, in order to receive the appropriate feedback. In this way, the patient can keep track of his/her health information and can feed the system with parameters related to their disease, while the doctors can also review the patients’ information.

Therefore, the proposed system is aimed at both physicians and chronic patients, and provides a personalized communication tool for each user.

With this customization, patients will be able to consult and edit relevant information from each one of them on a daily basis, receiving feedback from physicians. Conversely, it gets easier for doctors to manage their patients and they can check at any time the state of their patients, evaluating and checking their progress.

The main objective of the system is the design and development of a clinical tool which allows both doctors and patients to access clinical data of patients through monitoring and editing customized data and to make public all the digitalized information about those patients

This main aim can be divided into a series of more specific ones:

- To provide a personalized service to each user.
- To facilitate medical management of chronic patients.
- To allow a more effective communication between doctor and patient through the exchange of information.
- To access to clinical data, and reports at any time.
- To develop a secure information exchange using SSL.
- To ensure doctors’ feedback to patients on a regular basis without the need of visiting the clinic, regularly.
The article is structured into four sections: Section 2 explains the proposed system, which explains the steps followed to carry out the project and the proposed system design, Section 3 shows the technical and satisfaction results obtained from the system, and Section 4 presents the conclusions of the authors after the project tests, followed by the author’s reflections.

2. Proposed System

This section explains the methodology followed to implement the project and the proposed system.

2.1 Material and Methods

2.1.1 Human Resources

For the design, development and validation of this project a very implicated multidisciplinary group formed by: engineers, doctors and patients was set up. In the validation 3 doctors and 8 chronic patients intervened, who are to be the final beneficiaries of this development. All the patients have signed the ethical consent to be included in this study.

The chronic diseases suffered by the patients are: hypertension and diabetes.

2.1.2 Methods

To determine the functionality of the project and the technologies to be used, meetings have been made periodically, in which some aspects have been defined:

- **Technology to use**: To determine the technology to be used, a comparison has been made between the technologies which best suit the project. The advantages and disadvantages of each one have been evaluated. Once tested, the technology selected to implement the interface of the application has been Jommla! [10] + php [11] because it provides a very important support for content management. In order to develop the web services, .NET has been chosen.
  - **Profile and users access**: Depending on the role of the person, i.e., physician or patient, he/she can edit, view or validate data. Moreover, it has been defined which data can each patient access.
  - **Functionality of the project**: The functionality of each module forming the platform has been defined.
  - **Navigation mode and data presentation**: The optimal mode of navigation between the screens has been determined for the users. In this step the collaboration with the physicians has been very important due to the fact that they have been those who have marked the needs of the implemented tool.
  - **Security protocols**: As the information used to feed the system is very critical, the https (Hypertext Transfer Protocol Secure) and SSL (Secure Sockets Layer) [12] security protocols have been integrated in order to send the information.

2.2 Proposed System Design

The high-level application (see Figure 1) has a client/server, the platform comprises the database layer, web services layer and interface layer.

The novelty incorporated in this architecture is related to the web services layer. This layer is divided into two, developing and hosting the web service on two separate servers, which results in the generation of two
sub-layers, which the author has called Application logic web services and Database access web services (see Figure 2).

- Application logic web services: The web services hosted on this layer are responsible for receiving requests from the interface layer and therefore they form the logic of the application.
- Database access web services: These web services are responsible for making requests to the database and receive requests from the Application logic services.

The advantage of the subdivision of this layer is the achievement of a greater independence between the presentation layer and database layer, getting a lower coupling between application logic and the data used, thus allowing a better system design and scalability.

Regarding the interface layer, it provides access to both doctors and patients in order to monitor the patient’s evolution, the different medical parameters and check through the surveys in what state the chronic patient is. This layer displays the feedback that they receive both doctors and patients.

3. Results

This section shows the technical and social results which have been obtained during the development of the project and through testing the platform with final users.

3.1 Technical Results

The developed system is oriented to both doctors and patients.

The doctors access to the different parts of the system to check and validate the information that has been inserted by the patients, with the aim to bring a more exhaustive control of the patients’ evolution.

The patients have to insert some parameters, such as vital signs and complete surveys that are related to the patients’ disorders, in the platform. Through this information, the patients can check their own evolutions.

3.1.1 Vital signs

In this module, the patients’ vital signs are shown. These signs are specifically related to the illness of each of them. The users must insert the values every day to allow the doctors to keep a control of them.

To obtain a general vision of the evolution of the vital signs along the time, the system gives the possibility of visualizing each value in a graphical way (see Figure 3-A).

3.1.2 Medical Surveys

The aim of this module is to obtain information about patients’ status through questions related to the patient’s situation.

The users answer “yes” or “no” to a series of closed questions (see Figure 3-B).

The doctors are responsible for checking the surveys.

3.1.3 Progress

This module gives feedback to the patient about how she/he is progressing. This is achieved through the doctor’s comments and observations.

3.2 Social Results

This section explains the subjective and objective results that were obtained from the project.

- Objective results

The proposed system has been proved by 8 patients with chronic diseases and 3 doctors. To evaluate the usability, a survey has been done. The survey was based on a SUS (System Usability Scale) survey [13], which has been adapted to the needs of the project.

Therefore, series of questions have been asked (see table 2) where users have answered to each of them selecting a value from 1 to 5 (1 being “strongly disagree” and 5 being “strongly agree”).

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Do you think the system is easy to manage?</td>
<td>4</td>
</tr>
<tr>
<td>2- Would you use the system to keep track of your illness?</td>
<td>4.1</td>
</tr>
<tr>
<td>3- Is the information displayed useful?</td>
<td>4.6</td>
</tr>
<tr>
<td>4- Would you need the support of an expert to navigate through the application?</td>
<td>2.5</td>
</tr>
<tr>
<td>5- Is the data display comfortable?</td>
<td>4.2</td>
</tr>
<tr>
<td>6- Do you need previous knowledge to use the application?</td>
<td>2.7</td>
</tr>
<tr>
<td>7- Do you think the system is adequate?</td>
<td>4.7</td>
</tr>
</tbody>
</table>

The average results obtained has been equal or higher than 4 for the questions related with the type of data.
displayed and the user’s opinion about the usability of the system.

Moreover, we have obtained a lower score when assessing the difficulty of the system, which proves that users consider the application useful and easy to use. Users agree that the system displays useful information and that their display is adequate. However, there is more disagreement on the issue related to learning and system management. This is due to the fact that the users’ knowledge of computers is quite limited. For this reason the learning curve of the application for this type of user has been slower than the rest of users with more advanced knowledge. In spite of this, once users have learned to manage the system, they are satisfied with it.

The authors want to remark that the doctors’ survey is a little different. There is only one question which is common is item 1. And in this case, the feedback provided by the doctors is that in their opinion, the system id friendly but it could be improved in the near future with more functionalities.

- Subjective results

The proposed system improves the communication between doctor and patient. The doctors have assessed the system very positively because it allows a more exhaustive control of their patients with the vital sign module, in which the patient inserts their parameters periodically.

This allows the doctor to check for any significant change, and can therefore act immediately if it is necessary.

On the other hand, patients have indicated that they have more confidence in this system because they are being monitored by the doctors daily in a more exhaustive way, with more regularity than in traditional health system, due to the fact that they can see how the doctor examines the data which are introduced by them.

Therefore, the feedback that the doctors and patients obtain through the system permits to detect more quickly deviations that the patients may suffer and in this way to avoid possible risks.

4. Conclusion

The developed system has been accepted both by patients and doctors (during the pilot stage) in a very positive way. Access to information at any time and the possibility of being able to control the progress, both by patients and physicians, in a simple and intuitive way has facilitated the acceptance of the system.

It is important to mention that the feedback obtained by the chronic patients when the physicians assess the data entered by them and through checking the comments made by doctors, makes the confidence of patients increase and makes them have the perception of being monitored in an exhaustive way.

It is noticeable that there is great interest aroused by these applications in the field of chronicity due to the close relationship between doctors and patients, and the times this kind of patients need to visit health systems.

In conclusion, nowadays, new eHealth systems are having a great impulse and importance, helping to facilitate the treatment, control and evaluation of patients. With these, personalized attention to each
patient is enhanced. Patients’ satisfaction and knowledge about their diseases also increase.
What kind of information should be allowed to travel on the network or in the cloud? How safe are these new systems? Elderly patients or people without technical background rely in this kind of systems? The background of the users is critical to the success of the proposed system. These kinds of issues can arise for patients, because the information being handled is very important and confidential. Therefore, the projects must meet prescribed security protocols, give confidence to patients and encourage them to use these systems. In this way, a closer monitoring of their evolution is achieved, lessening the risk of missing the early detection of any potential major problem in a chronic patient.

Acknowledgements

This work was partially supported by the Basque Government Department of Education, Universities, Research, and Basque Government department of Industry, Innovation, Commerce and Tourism. The authors would like to thank all participants involved in the study, the cooperation of the companies Gomosa, Inviza, GAIA and Letralan.

References