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Development of a web system for the record of Clinical History in patients of the State Center for Critical Care in Salamanca Gto.

Desarrollo de sistema web para el registro de Historial Clínico en pacientes del Centro Estatal de Cuidados Críticos en Salamanca Gto.

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Abstract

Software development is a common practice carried out for different institutions, both public and private. The purpose of these developments is to improve processes, streamline tasks and keep a record and control of the information so that it can later be used for decision making. The development of the Clinical History software for the State Critical Care Center in Salamanca Guanajuato (CECCS) by the Academy of Network and Telecommunications Engineering of the Polytechnic University of Juventino Rosas, meets the requirements requested by the CECCS. This system was requested to replace manual processes that are carried out by medical and nursing personnel; these processes will be replaced by a digital registry, where the information will be permanently recorded in a database. This system starts with the registration of the patient who enters the CECCS for hospitalization, the system will assign a file number for its control. By means of this file number, the nursing staff will generate the records of both diagnosis and medications administered in the three shifts (morning, afternoon and night), these records will be carried out by means of the sheet concept (one sheet will be recorded per day of the patient's hospitalization) where each sheet will contain six pages which contain: physiological parameters, hydric response, respiratory parameters, clinical parameters, neurological assessment, device infection risk assessment, pressure ulcer assessment, burns assessment, pharmacotherapies, intravenous therapy, diagnosis and nursing standards. This system also has a role control per user, where, depending on the user's role, are the options that can be executed within the system. There is a user authentication at the beginning of the system, so that only authorized personnel can use and register the information.

Software, System, Model, Requirements

Resumen

El desarrollo de software es una práctica común que se lleva a cabo para diferentes instituciones, tanto públicas como privadas. Estos desarrollos tienen la finalidad mejorar procesos, agilizar tareas y llevar un registro y control de la información de tal manera que posteriormente se pueda hacer uso de ella para la toma de decisiones. El desarrollo del software de Historial Clínico que se llevó a cabo para el Centro Estatal de Cuidados Críticos en Salamanca Guanajuato (CECCS) por parte de la Academia de Ingeniería en Redes y Telecomunicaciones de la Universidad Politécnica de Juventino Rosas, cuenta con los requerimientos solicitados por el mismo CECCS. Este sistema se solicitó para sustituir procesos manuales que se llevan a cabo por parte del personal médico y enfermería, éstos procesos se sustituirán por un registro digital, en donde la información se quedará registrada de forma permanente en una base de datos. Este sistema inicia con el registro del paciente que ingresa al CECCS a hospitalización, el sistema le asignará un número de expediente para su control. Mediante este número de expediente, el personal de enfermería generará los registros tanto de diagnóstico, así como de medicamentos administrados en los tres turnos (matutino, vespertino y nocturno), estos registros se llevarán a cabo mediante el concepto de hoja (se registrará una hoja por día de hospitalización del paciente) en donde cada hoja contendrá seis páginas las cuales contienen: parámetros fisiológicos, respuesta hídrica, parámetros respiratorios, parámetros clínicos, valoración neurológica, valoración de riesgo de infección por dispositivos, valoración de úlceras por presión, valoración de quemaduras, farmacoterapias, terapia intravenosa, diagnóstico y estándares de enfermería. Este sistema también cuenta con un control de roles por usuario, en donde, dependiendo del rol del usuario, son las opciones que podrá ejecutar dentro del sistema. Existe una autenticación de usuario al inicio del mismo, esto con el fin de que solamente personal autorizado pueda hacer uso y registro de la información.

Software, Sistema, Modelo, Requerimientos

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1. Introduction

The computer system is a tool that is used to speed up the daily work in any work environment, it has become one of the most important activities nowadays. To carry out software development it is necessary to consider several factors such as costs, planning, difficulty, available work team, programming languages used, etc. (Gómez, M., Cervantes, J. & González, P., 2019). All of these are encompassed in a software development methodology that allows the work to be organised in the most orderly way possible.

Developing a product without a clear methodology will make the project even more complex, leading to problems, delays, errors and a bad result in the end.

As well as different institutions, organisations or companies, the Centro Estatal de Cuidados Críticos de Salamanca Gto. (CECCS), has the need to have a system that registers both the diagnosis as well as the medicines administered to the hospitalised patients in the three shifts during their hospitalisation.

There are different computer systems that can be used in health centres, however, it is necessary to highlight the importance of having a customised system. In this case, the software developed was created specifically for the needs of the CECCS, which provided us with the different needs they had in the area of patient hospitalisation, specifically in the registration and control of diagnoses and medicines, among others.

2. Methodology

For the development of the Clinical History software, a RUP (Rational Unified Process) methodology was used, where, like the rest of the methodologies, it is carried out through a series of steps or tasks that are iterative (Academy & Martinez, 2017).

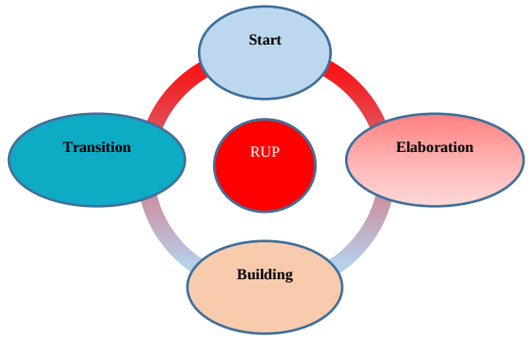

Figure 1 Life cycle of the RUP model
Source: (López, R. & Pech, J., 2015)

This methodology is characterised by being iterative, as the four phases shown in the image are executed as many times as necessary to complete the project, as shown in Figure 1, where at the end of one phase, the next phase must be continued and not the other way around (C. & A., 2020). These phases are initiation, elaboration, construction and transition, which will be executed as many times as necessary to conclude the system.

a) Initiation phase

In this phase, the client's needs are gathered through interviews with the CECCS nurses' manager, where the following requirements were identified:

No	Requirement	Type of requirement
1	Validate user access.	Functional
2	That certain people can only make changes.	Functional
3	There should be an option for certain people to consult the information only.	Functional
4	To be able to do on the computer what is captured in the manual record sheets.	Non-functional
5	That the sheets that are made manually on the computer can be recorded.	Functional
6	There should be an option for users to enter data.	Functional
7	The system can be installed on a tablet or mobile phone.	No Funcional
8	To be able to register a file for each patient.	Functional
9	Record general patient data.	Functional
10	Keep track of the number of days the patient is hospitalised.	Functional
11	Make queries of the information recorded for each patient.	Functional

Table 1 Requirements identified
Source: (Pantaleo, G., & Rinaudo, L., 2016)

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Table 1 represents the functional requirements of the system through diagrams of use cases, each of the cases are the options that the clinical history system would have. This diagram also represents the actors or users who will interact with the system, identifying the options to which they will have access in the system.

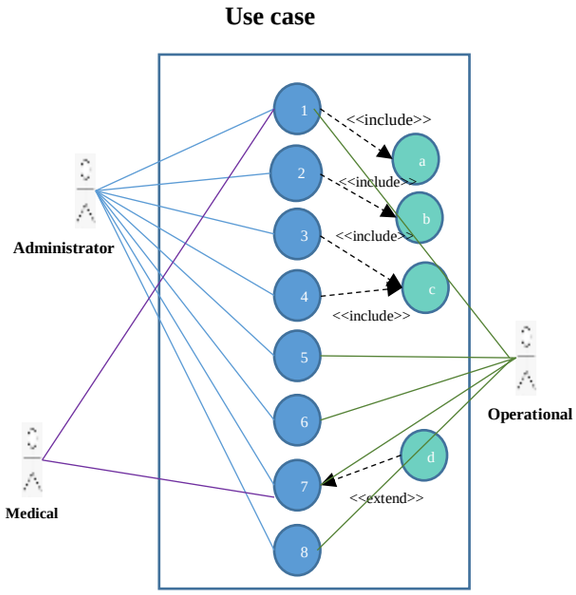

Figure 2 Diagram of use cases of the clinical history system

b) **Elaboration phase**

In this phase, the design of the parts of the system begins, such as the entity-relationship model that will later become the structure of the database, as well as the class diagrams, sequence diagrams and requirements for the system to be executed.

Entity-relationship model:

The entity-relationship model diagram is one of the primary tasks that must be carried out, as it is the one that will define the structure of the database, here each of the entities, attributes of each entity and the relationships between them are identified.

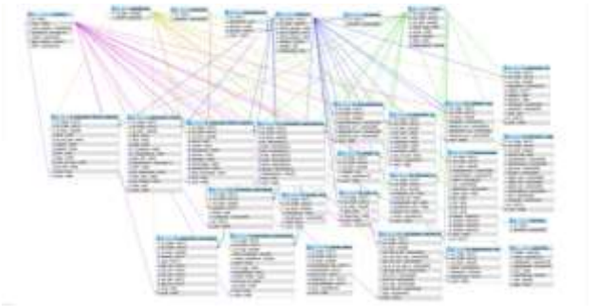

Figure 3 Entity-relationship model of the Health Record system

Figure 3 shows the relationships of the entities, which were identified after the analysis of the user requirements.

System architecture

The system architecture diagram represents the structure that the system will have, as well as its different components (Ingeniería y Arquitectura del Software | IT Campus Academy, 2017).

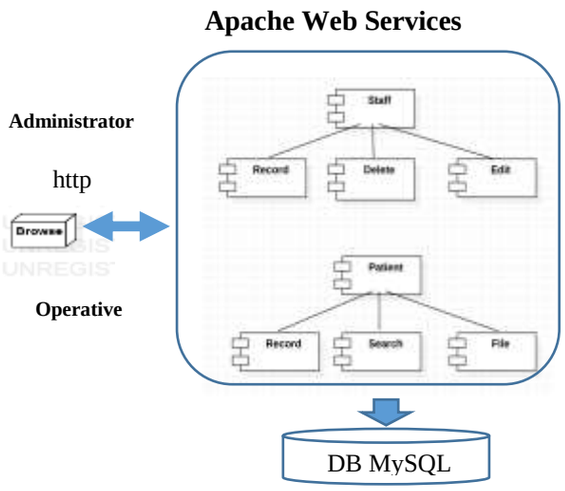

Figure 4 Architecture of the Clinical History system

Figure 4 shows the system components and their relationship with the users (Administrator, Operational and Medical), as well as identifying the browser (browse) which is the platform on which the system is executed and the database where the information generated is stored.

Sequence Diagram

Another of the diagrams that must be developed is the sequence of the system, in this diagram it is described graphically how access to it will be (Wiegers, K. & Beatty, J, 2013).

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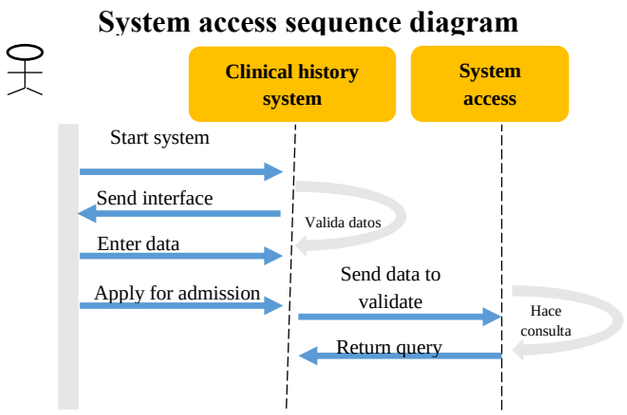

Figure 5 Sequence diagram of access to the Health Record system

Figure 5 describes the steps that will be taken for each user, regardless of role, to access the system.

The sequence diagram is a representation of the steps that will be followed each time a user accesses the system (Booch, G., Rumbaugh, J., & Jacobson, I, 2010), it is worth mentioning that there is a sequence diagram for each of the functionalities of the system.

c) **Construction Phase**

In the construction phase, the development of the different iterations of the system is carried out (Gomez, S., & Moraleda, E., 2020). The programming tools used are: html 5, css, php, javascript, as well as the MySQL database manager. The IDE used for the development is the sublime text version 3.2.2.

d) **Transition phase**

In this phase, the system will be delivered to the CECCS for final testing in the same centre.
The main interfaces of the medical records system are described below.

e) **System access interface**

Figure 6 shows the first interface that is presented when accessing the system and where users must authenticate their access.

Figure 6 Access to the Clinical History system

Initial interface of the system where access will be by means of the professional card number for both nursing and medical staff.

The registration of these cards will be done by staff with Administrator permissions

a) Role interface for users with administrator permissions

The Administrator user is the one who has access to all system options, including adding users, changing user status from inactive to inactive, registering patients, records, creating folios and making queries, among other options.

The Administrator user, see figures 7 and 8, can access the Staff and Patient options and is the only user who can execute the options in both menus.

Figure 7 Administrator user interface Personal option

Figure 8 User interface Administrator option Patients

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b) Operator user interface

The user with operator permissions can only access the Patients menu option, where he/she can register patients, create a record, and create the necessary folios in case the patient requires hospitalisation.

Figure 9 Operator user interface Patients option

Figure 9 shows the three options to which the user with operator characteristics has access, these are: Register patient, Search patient and Create Record.

c) Medical user interface

Users with these permissions will only be able to access record consultation, as shown in Figure 10.

Figure 10 Medical user interface option Patients

Although in Figure 10, the Patients option shows three options (Register, Search, Record), users with Doctor permissions only have access to the Record option and only as a query.

This system is currently being tested by the development team. Two tests are being carried out on the system:

a) Functional Testing:

Functional testing focuses on the business requirements of an application. They only verify the result of an action and do not check the intermediate states of the system when performing that action. Integration testing is sometimes confused with functional testing, as both require various components to interact with each other. The difference is that an integration test may simply verify that you can query the database, while a functional test would expect to obtain a specific value from the database, as dictated by the product requirements (Arias, A., & Durango, A, 2016).

b) Comprehensive Testing:

Comprehensive testing replicates a user's behaviour with the software in a complete application environment. They also verify that various user flows work as intended, and can be as simple as loading a web page or logging in, or much more complex, such as verifying email notifications, online payments, etc. Comprehensive tests are very useful, but are costly to run and can be difficult to maintain when automated. It is recommended to have a few key end-to-end tests and rely more on lower level tests (unit and integration) to be able to quickly detect new changes (Gomez, S., & Moraleda, E., 2012).

These tests are carried out mainly to verify possible errors in the execution of the different options and at the same time check the full functionality of the functions assigned to each of the user types (Administrator, Operator, Doctor).

Once the above tests are completed, the system will be installed on the client's server, which will have a period of 30 days to test the system in the State Centre for Critical Care of Salamanca (CECCS), if errors occur in the execution should be reported to the development team for attention. If there are no errors, the system will be put into production at the CECCS.

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3. Results

The results presented are according to the types of functional tests, this type of tests are related to the system executing the functions for which it was programmed. In the following, the results of two of the main functions of the system will be shown: system access and file registration.

Access to the system: this function is the one that will allow or not the access to the system to the different users of the CECCS, for which, each user has different permissions, administrator, operator and doctor, so that every user that requires access to the system must be registered in the system or otherwise he/she will not be able to access it.

Figure 11 System access interface

For access, the user must enter his/her ID number and password, as shown in Figure 11, to gain access to the system. These data should have been previously registered by the administrator user who has the privileges to make these registrations. After the user presses the login button, the system must validate that the ID and password are registered in the database in order to give access to the next interface. If the above data is incorrect, the system will show error in the data, as shown in figure 12.

Figure 12 Error in accessing the system

System operation: These functions allow you to record the evolution of the patient while he/she is hospitalised.

Record register: this option has the function of registering the data of the patient who will be hospitalised. To do so, the data shown in figure 13 is requested, where the patient's personal data is requested, as well as the information necessary to keep track of the patient's stay in the hospital.

Figure 13 Record register

Each record is composed of folios, each folio is the number of times that the patient has been hospitalised, each folio has a sheet number, this sheet is each of the days that the patient is hospitalised, and each sheet has six pages, each page corresponds to each of the studies.

Figure 14 shows the interface where the data of file 290-C1 are registered, Folio #1, this folio number is because it is the first time that the patient is hospitalised, Sheet #1 corresponds to the first day of hospitalisation and page #1 corresponds to the physiological parameters, these parameters are registered in the three shifts, morning which is from 08:00 to 14:00 hours, afternoon which is from 15:00 to 20:00 hours and night which is from 21:00 to 07:00 hours of the following day.

Figure 14 Physiological parameters page

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Figure 15 shows page #2 corresponding to the respiratory parameters, from folio #1, sheet #1, file 290-C1.

Figure 15 Respiratory parameters

Figure 16 shows page #3, which is where the data of the resulting assessment made by the staff to the patient with respect to burns, falls and PU control presented by the patient are recorded. This page still corresponds to file 290-C1, folio #1, sheet #1**.**

Figure 16 Assessment of burn, fall and PU control

Figure 17 shows page # 4 corresponding to the diagnosis and clinical standards for nursing in nutrition from file 290-C1, folio #1, sheet #1.

Figure 17 Diagnosis and clinical standards of nursing in nutrition

Figure 18 shows page # 5 corresponding to the diagnosis and clinical standards for nursing in stress tolerance from file 290-C1, folio #1, sheet #1.

Figure 18 Diagnosis and clinical standards of nursing in stress tolerance

Figure 19 shows page # 6 corresponding to clinical notes and patient evolution from file 290-C1, folio #1, sheet #1.

Figure 19 Clinical notes and patient evolution

Conclusions

Nowadays, software development has had great importance in the institutions, in the educational, business, health, services, etc. areas, since it has been considered a fundamental aspect to improve the services and the effectiveness of the activities that are carried out in those places. It is a reality that the world is becoming increasingly competitive, the objective is to increase efficiency at the lowest possible cost and time, so implementing automation programmes has made it possible to transform the operation of the labour sector to reduce the time in the execution of daily activities.

The use of technological applications in the health sector will improve the services provided to its users, given that through these applications it is possible to keep better control of information on patients, doctors, diagnoses, studies, hospitalisation time, among other important data. Being able to store relevant information on a permanent basis means that decisions can be made more quickly regarding the health situation of patients.

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The use of software is also important in the health sector as its implementation reduces the time and errors of staff recording information and improves administrative processes.

Among the benefits of software in the health sector are the registration of the information of each person who uses it, as well as everything that has to do with the patient's consultation (doctor, diagnosis, medicine, date of consultation, etc.).

Finally, given that the sector is an institution for the care of people, it is important that it has the necessary tools to improve this care by reducing time and costs.

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