

Implementation of a Georeferenced Survey System with Java Spring Framework using Controller View Model

Alicia Valdez , Sergio Castaneda, Gabriela Rodriguez, and Gerardo Haces

Abstract — Information systems support many purposes in organizations of any kind. Sometimes the information systems are used to know the tendency of the population on diverse subjects; surveys have become a public issue of relevance to people. In this project a web information system of georeferenced surveys has been developed and implemented to know the vote intention of the population of the Central Region of Coahuila. Using the Netbeans Integrated Development Environment with the Controller View Model pattern and MySQL for the database management.

As a result, the application has been designed to identify geographic coordinates of the areas of interest for the application of the survey through waypoints and tracks; which record exact data of the location of the interviewer; the spring web framework modules was used for the complete development of the application.

Approximately 2800 surveys were applied in a 3-month span, and it allows recording of the audio session for each one of the pollsters, according to the selected area and the corresponding sectional obtaining precise and exact data on the opinions of the respondents for subsequent analysis and graphing.

Keywords — Georeferenced system, MVC Pattern, Spring framework, Java, MySQL.

I. INTRODUCTION

The software is one of the strategic pillars of organizations and society, since many of its processes, products and services depend on a high degree of proper operation [1].

Progressive changes in the paradigms of development through the classical paradigms, to modern paradigms were presented with great significance in the history of software development.

In this regard Giraldo *et al.* [2] argues that there is a significant advance in the software industry to provide reuse mechanisms to increase the productivity of software with an increase in quality, which says that you one of the aspects important software development techniques in current and future is usability or code reuse.

In this regard Méndez [2] mentions that, in software development, usability is an issue that is gaining increasing importance for the ability to create software in less time.

Also, Holz [3] adds that software must answer increasingly faster to changes that come from the outside world, by increasing competition and because new domains where software plays an important role not permitted delays for those updates. Increased interoperability with other systems also will make systems that are not updated immediately are obsolete and cannot continue forming part of other "systems of systems".

For the development and analysis of web applications, it has been development numerous techniques that satisfies with this expectative. The desirable pattern for the web software development is the Model View Controller (MVC), which considered separate in three elements or layers throughout the project, being: control logic (know which elements have the project and what to do, but not how it was implemented), the business logic, know how develops the application, and the presentation logic, know how interacts the user with the application.

Spring Web MVC is the original web framework built on the Servlet API and included in the Spring Framework from the beginning. The formal name "Spring Web MVC" comes from the name of its source module spring-webmvc but it is more commonly known as "Spring MVC". Spring MVC, like many other web frameworks, is designed around the front controller pattern where a central Servlet, the Dispatcher Servlet, provides a shared algorithm for request processing while actual work is performed by configurable, delegate components. This model is flexible and supports diverse workflows [4], [5].

With the implementation of this pattern, it has obtained better quality and a better knowledge.

The layer of the model is required to generate a Data Access Object (DAO) class, for each consulting structure that is required and a Data Transfer Object (DTO) class, with the aim of exchanging communication with other layers, shown in Fig. 1.

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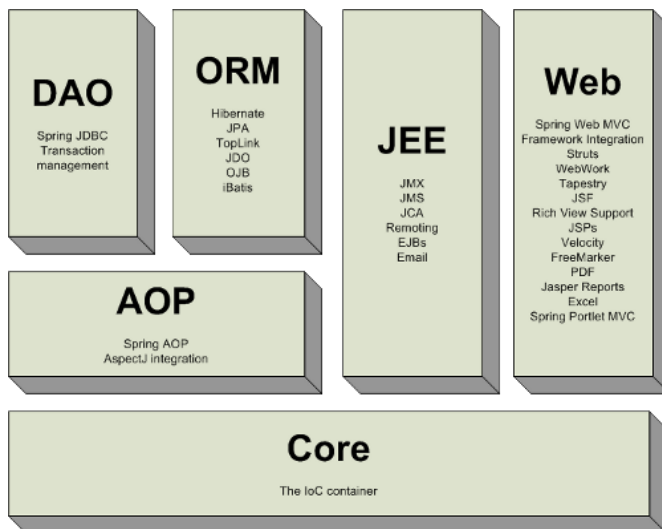


Fig. 1. Spring modules, source [5].

In the case of the processing of an HTTP request, in Spring MVC, on the Front Controller, was managed the class DispatcherServlet to serve the request Universal Resource Locator (URL), was handled HandlerMapping class, is called the Controller that performs the business logic, obtains the results and returns them to the Servlet, encapsulated in an object of type Model. A ViewResolver does find the physical name of the view, which corresponds with the logical name in the previous step. Finally, the DispatcherServlet redirects the request to the view, which displays the results of the operation, see Fig. 2.

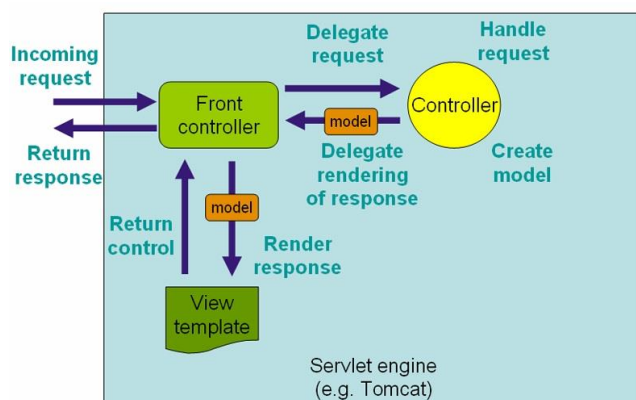


Fig. 2. MVC Sample source [6].

The implementation of the MVC pattern is not easy, when applications are developed on a large scale. The entire process which suggests the pattern involves a series of monotonous actions, which absorbs too much time and effort on the part of the developers. Regardless, the time that is required to document and structure all the project properly, (according to the individual's programmers). It must also add the time used in the correction of errors and code testing. The sum of all these hours of time invested for the development of a project using the MVC pattern involves too many costs [7], [4], [6].

Considering these antecedents, it is necessary to develop several automata that allow the coding of the MVC structure of the pattern, which can decrease the programming time from 60 to 70%, these values are obtained by evaluating the time it took to program an internet application where around 25 tables were managed in a project, using the MVC pattern without using the application and then using the application [8].

The 10% of slack is due to the skill of the programmers, it should be mentioned that all the programmers involved had a basic level in the Java language. Whereas such evaluation is observed that there is cost reduction by fees of programmers and development time, is not only considerable reduction of development times for medium-sized projects, but a bigger size of the larger project is improving.

II. THE WORD WIDE WEB

Interface web design is a complex issue in which not only involved graphic design and programming processes, but they are also essential aspects of the architecture of information, navigation, functionality and, above all, usability [9].

Web engineering refers to the methodologies, techniques and tools used for the development of complex web applications, which supports the evaluation, design, development, implementation, and evolution of such web applications. They have certain characteristics that make it different from the development of applications or traditional software and information systems.

It is important to consider that it is multidisciplinary, brings together contributions from: architecture information, hypermedia/Hypertext engineering, design of the user interface, graphics, usability, systems analysis, software engineering, engineering of data, indexing and information retrieval, testing, modeling. As well as simulation, deploy applications, operation systems and project management [7].

It is not a clone or subset of software engineering, although both include software development and programming, web engineering uses software engineering principles, includes new approaches, methodologies, tools, techniques, guides and patterns to meet the unique requirements of applications [2]. See Fig. 3.

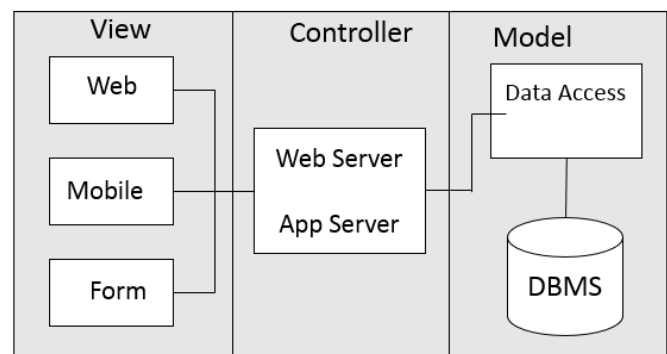


Fig. 3. MVC pattern related to web technology.

III. MVC ARCHITECTURE

Model, view and controller pattern is the most widespread for the development of applications, where user interfaces should be handled, this focuses on the separation of data or model, and the view, while the driver is responsible for linking to these two [10]. Its main feature is to isolate the model view [11]-[13]. In Fig. 2 the separation of the three layers and components that make it functional by having independence between layers, can be seen.

Main advantages of using the MVC pattern are:

1. Allow the replacement of the user interfaces.
2. Generate interfaces components.
3. Design of simultaneous views of the same model.
4. Easily apply changes to interfaces.
5. Also, certain problems have been identified as:
 - a. Complexity increases rapidly.
 - b. The view and the model are much attached.

Whereas the mesh as the degree of interdependence between units as modules, functions, and subroutines software of a computer system. In this sense in the MVC pattern, the data access depends directly on the same model as is mapped through the SQL query (view), therefore the DTO and DAO correspond to a very attached to the view structure, since the objects of Exchange (DTO) depend on directly in the DAO and the generation of them depends directly on the model.

The development of this application involves generating the MVC pattern code in java, which allows generating subprojects or sections of a project and being able to be coupled to a final project.

In order to modify a project that has already been completed (provided it has been developed with this same tool), offering the possibility of expanding the projects already generated in the future, through the implementation of several coordinated automata that generate the entire structure of the MVC pattern required in an appropriate, uniform and consistent manner with the required project, in addition to the documentation inherent to the project. All this from the script generated by a database modeling tool.

This will mainly help developers to go directly to the business layer, feeding the main class getting a substantial increase in the speed of development of any project with uniformity of the obtained code, with its respective documentation, allowing future updates and strengthening the usability of the future software.

The principal target was the design and build an automaton that implements the MVC pattern in the web-oriented project in the management of Geo-referenced surveys for the taking of field data, using Google Maps GPS.

The objectives of the project were:

1. Design model of the automaton that allows the coding of the MVC pattern, to collect information about the position, length, and area of geographic features.
2. Process the data collected in the field.
3. Development and implementation of an automaton for the homogenization of SQL scripts.

4. Design and implementation of a dynamic structure that allows to identify the relationships in the schema of the database, their data dictionary and the views.

5. Development and implementation of the SQL scripting parser to create the dynamic structure.

6. Development and implementation of algorithms to generate MVC pattern layers.

The hardware and software requirements were:

1. For the programming of the automata, the handling of the object-oriented paradigm in the JAVA language is considered.
2. Software for 64 bits.
 - a. JAVA JDK environment version 2017.
 - b. MySQL database server version 2017.
 - c. Workbench scripts 2017.
 - d. Netbeans IDE ver. 8.2.
 - e. Windows 10 operating system.
3. Development hardware 64 bits.
 - a. Dell laptop Intel core I5 processor.
 - b. 8 GB Ram memory.
 - c. 1 TB hard disk.
 - d. 14" HD 1280 megapixels screen.
 - e. Multimedia system.
 - f. Windows 10 operating system.
4. Testing Hardware.
 - a. Tablet Samsung Galaxy SM-T560 32 bits with GPS.
 - i. Operating system Android 4.4.4 operating system.
 - ii. 4 Mb Ram memory.
 - iii. 64 Mb memory.
 - b. HTC cell phone with GPS.
 - c. Android operating system ver. 5.2
 - d. 2 Mb Ram memory.
 - e. 54 Mb memory.

IV. METHODOLOGY

The geographic coordinates of a given point were determined, because of the reception of information generated by Google Maps, coming from the classification of zones and sectionals, determined by the National Electoral Institute in the city of Monclova, Coahuila, Mexico.

For purposes of tracking routes, location and monitoring people under certain cartography. Fig. 4 shows the map of zone 1, which, in order to be functional with the application, requires that the area be selected with a certain color so that at the time of conducting the surveys work is carried out in the corresponding area assigned by the administrator; the platform allows the list of "n" types of surveys, "n" surveyors and a maximum of 6 areas and each area with its corresponding sectional according to the map provided by the institute. Some of the fundamental concepts for the functionality of this application were the following:

Identify the geographic coordinates, which allow us to accurately locate a place on the surface of the earth, these sets of lines correspond to the meridians and parallels.

Editar Área

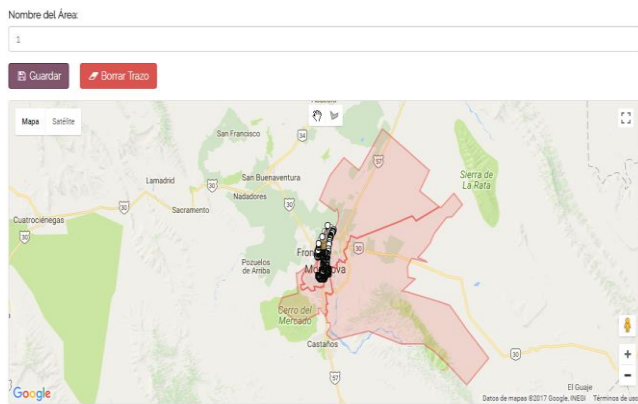


Fig. 4. Area map.

The meridians correspond to the highest circles passing through the Poles, divided into 180 meridians to the east and 180 meridians to the west, there are a total of 360 meridians in total.

The longitude is the distance in degrees, between any meridian and the Meridian of Greenwich that is a universal point of reference, the meridians have been mapped in intervals of 10°. Example: The city of Xalapa, Mexico is 19° 32' North latitude and 96° 55' West longitude.

In the memory of the GPS receiver, a waypoint contains the coordinates of the position that defines where part of the world is located, in this case it applies only to the city of Monclova and its surrounding areas. Usually, the waypoint is associated with altitude, latitude, date, time, and a comment, in this case related to the surveyor's data, the area, the sectional and the response number that is being made.

A track is a concatenation of waypoints, one behind the other, to define a route, some of the GPS saved from 10,000 to 50,000. As shown in Fig. 5, where the route made through the track is indicated and is taken by the person who is going to carry out the survey, according to the date, the zone and the sectional that corresponds to it.

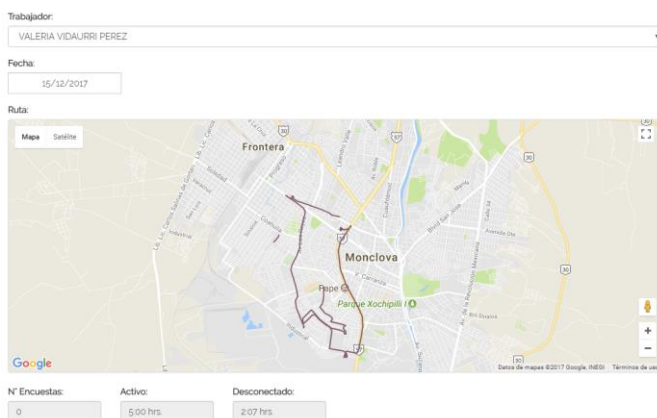


Fig. 5. Track.

V. APPLICATION

For the application design, the Unified Modeling Language (UML) was used, which will allow a complete understanding of the project, as well as the generation of documentation of the software architecture for future maintenance.

A deployment diagram is used to show the configuration of the elements of the process at runtime and the software components, artifacts and processes that are found in them, which are formed by nodes and communication routes.

For the options menu of the application, in the survey load section (the type of survey and the question load are defined), the work area is loaded to develop the survey (already mentioned previously), the surveyors and the type of survey to be carried out, among others, the main node would be the Message Broker, the MySQL application server, for the main database. In addition to defining the route, the location and the role that the user will follow in the cloud where the entire application is loaded for the traceability of the map.

The logical architecture of a system allows to clearly define the way in which the main components should be developed. For the Surveys system, it was defined by the 3-layer architecture: Presentation (Listening to people), Service (Business logic) and DAO (Access to data). This type of architecture allows us to separate the income of requests in audio or surveys through these layers.

Later, once the dynamic structure is configured: the tables, their attributes and views that will make up the project or subproject; also, it is decided if the project will be managed as a web service, web project or local application, then the connection to the database is established.

The scripts required for the database created physically with Mysql Workbench are designed and generated. subsequently, the SQL files must be homologated to a predefined standard, with the aim of only having all the necessary elements to be used by the automaton. See Fig. 6.

To comply with the last objective of creating the code of the MVC model in Java, we start from the generators that make several tours about the transformed dynamic structure

To extract the schema from the database and create the DTO objects by mapping them into Java, we proceed in the same way to perform the queries and update the DAO, while taking the names of the tables for the methods of the Facade classes and Delegate.

For the model layer it is required to generate at least one DAO class for each query structure that is required, and a DTO class, as an exchange object for communication with the other layers.

For the Service control layer, a Facade class is added for each one of the created DAOs and a Delegate class is added, grouping all the Facade created, to later link the Delegate generated to the view layer with its corresponding Framework. To achieve the appropriate creation of the layers, it was considered to integrate an xml configuration file for each code generator (gd, gf, ga, gt), and some compatibility libraries that can either be configured from the interface or taken in their

default configuration, which allows to generate each of the MVC pattern layers, as shown in Fig. 7.

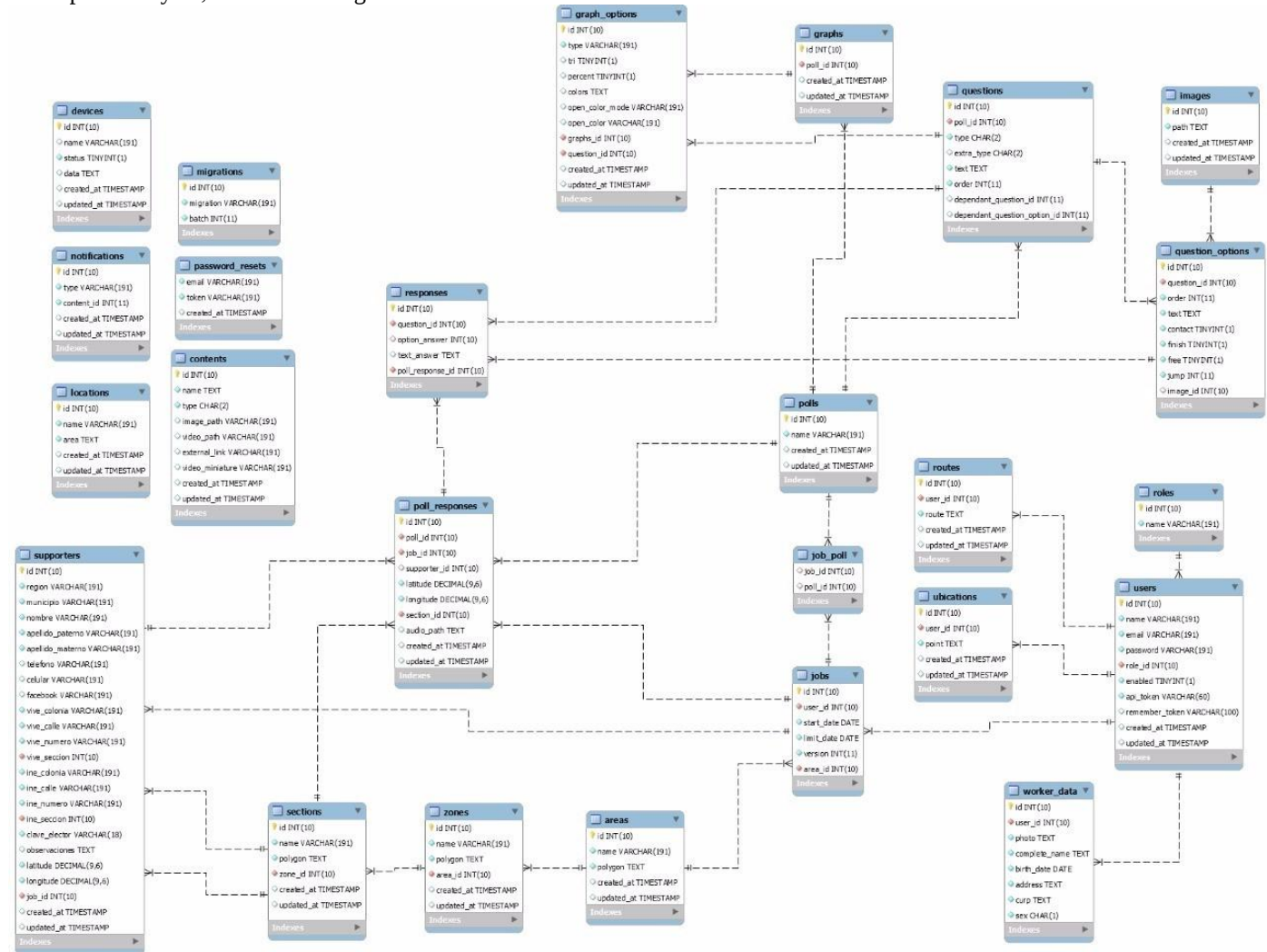


Fig. 6. Database diagram.

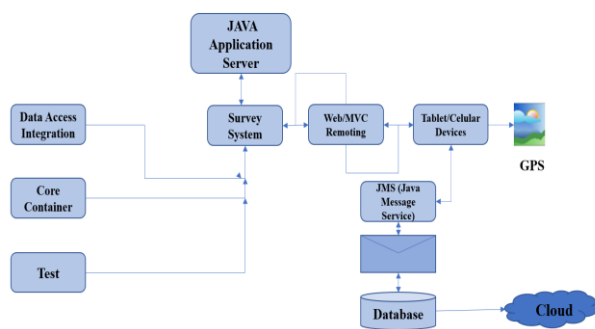


Fig. 7. MVC pattern layers.

For the development of the surveys application the following technologies were used, these are shown in Table I.

It was determined that the Java application language is based on the support, documentation and help available. This gives us a fairly high level of robustness for the application, since Java has a level of leadership worldwide as the language of greatest business demand.

TABLE I: TECHNOLOGIES

Technology	Description
Java	Object oriented programming language.
Spring Framework	Software development framework in the Java programming language.
JMS	Software for calling applications asynchronously in Java Message Serving.
MySQL	Open source relational database.
Apache	Message Broker for managing asynchronous communication messages between applications.
QuartzScheduler	Java application planner.
NetBeans 8.2	IDE for the management of Java applications.

It is a framework formed by a series of modules, which are used and applied for the development of business systems, and also provides compatibility with other frameworks, such as EJB, JSB, Struts, as shown in the Fig. 2.

In the development of software applications, it is very important to handle procedures or remote functions, which are necessary for this application, especially for the management of contents that are downloaded from the GPS. In JMS,

asynchronous communication is provided through JMS, the message broker, or Message Broker, it is an intermediate application that is operative in a server to process and redirect the messages that are sent to it. In this application the message broker "Active MQ" was managed, which is developed by the Apache community, providing extensive support and documentation.

Excellent task scheduling application running the work in a certain amount of time at a certain time of day, it is integrated into the Spring Framework allowing a rapid development and configuration of the application.

The following criteria were defined to guarantee information security.

- There is an Administrator whose main function is to assign and configure users, establish security policies, evaluate the logs and take measures regarding the performance of the database derived from the management of multimedia files (audio).
- There are staff that activate mobile devices such as tablets and cell phones, that must be counted so that the surveys application, which is based on the Android operating system, can operate.
- There is a staff that supports the generation of surveys and the allocation of tasks from the current survey to load mobile devices that support users of the system.
- The bases of the OWASP methodology were used.

VI. FINAL RESULTS

As a result, an application was obtained that manages the control of Surveys and allows the recording of the audio session by each of the interviewers, according to the selected area and the corresponding section. This proposal involved the work with zero knowledge of Spring MVC, a total of 25 tables were handled, to generate the MVC model code, it took approximately 3 months, since the project started.

Considering the above the application of MVC Surveys, has a high performance, which can save months of programming in the MVC pattern structure and ensure a homogeneous structure which is currently free of errors and operating with a total of more than 2,800 surveys conducted, as shown in Fig. 8.

Another important aspect is the ability to reuse code since the MVC Surveys system allows adding subprojects to an existing project, so that the usability of the project is fully extended, since the interface can modify some properties and choose only what is necessary for the section of a subproject.

In such a way that if you have an existing project, you can generate the necessary objects for each of the layers of the MVC pattern, coupling to what has already been generated, this will only happen if the first part was generated with this same tool.

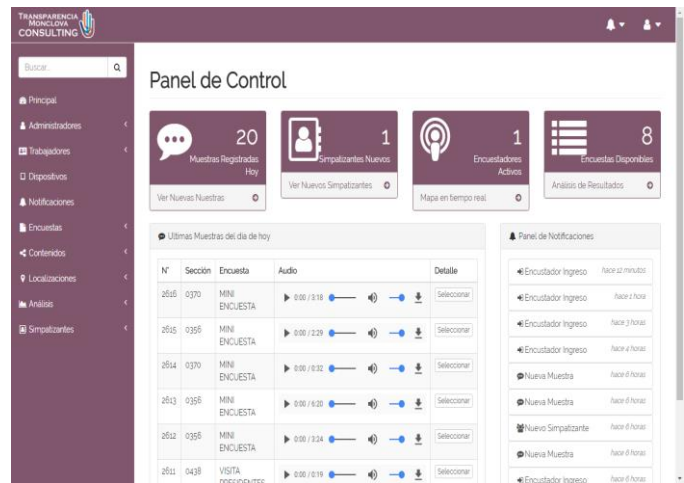


Fig. 8. Main screen of the Surveys application.

VII. CONCLUSION

Surveys MVC generates MVC pattern code in java language, Surveys MVC considers the indeterminate usability of the project so that subprojects can be added without losing continuity, as long as the initial project has been started with this tool. The use of MVC Surveys guarantees the consistency of the MVC pattern programming. With MVC Surveys the programming time that will be used in the programming that supports the MVC Surveys pattern is reduced, which makes it very versatile with an immediate impact.

The Surveys MVC software is at the forefront for the creation of information systems for the Web and work in a distributed manner, a situation that makes it a tool that will be used in future projects, and work is being done to improve the project to give support for the characteristics of future versions in the creation of software, as shown by the final analysis made from a group of people surveyed, see Fig. 9.



Fig. 9. Analysis made to 2,056 surveys.

Programming times are reduced, in this model.

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