Volleyball Information System

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Abstract—Volleyball Information System (VIS) is an information system that was built to be used as a support for the conduct of volleyball competitions, as well as the support for informing the public about volleyball. The system is composed of a central database where all the data is stored and of a set of web portals through which the authorized users can enter data into the system and through which the stored data is clearly presented to the public. This paper presents the case study of Croatian Volleyball Information System. The architecture, functionality and importance of the designed system are described.

Key words: information system, web, database, competition, sport, volleyball

I. INTRODUCTION

Nowadays many information systems are developed for sports competitions. Volleyball is one of the ten most popular sports in the world [1]. There are two versions of volleyball: the indoor volleyball (each team has 6 players) and the beach volleyball (each team has 2 players). When we are talking about the popularity of volleyball, it is enough to say that the beach volleyball tournament was the most attended one at the Sydney 2000 Summer Olympic Games and at the Athens 2004 Summer Olympic Games as well [2].

The popularity of the sport and its importance requires a serious approach to managing the data related to the volleyball entities and processes between them.

In Croatia, the indoor and beach volleyball competitions are organized separately. This paper presents Croatian Volleyball Information System which was developed for the indoor version of volleyball competitions in Croatia.

Volleyball competitions in Croatia are organized in a way that there are four levels of the senior league competitions. Super League and the first Croatian volleyball leagues are organized at the national level. The second and the third leagues are regional competitions that are played in four separate volleyball regions of Croatia. Except league competitions, in Croatia is also played Croatian Cup. Youth competitions which are played separately in four different age categories are also very important. Youth competitions as well as the Croatian Cup in their initial phases are played at the regional level. The best teams from all regions participate in the final national competition.

For the successful implementation of the volleyball competitions, it is necessary to have an information system that supports the conduct of the competitions as well as to serve as a medium that presents the desired information to the interested public. Quality competition monitoring, except recording the match results and generating the tables containing the team rankings, includes the recording of data about all the entities involved in the competition: the clubs, the teams, the players, the coaches and the referees. It is important to ensure that the data storage process is facilitated in an organized, searchable and a non redundant way.

The subsystem of the Volleyball Information System for managing the competitions enables the automatic generation of the league competitions using the Berger’s algorithm [3], the automatic generation of the tables with the team rankings in the each competition, the delegation of judges and delegates, and, for each team, the record list of all the registered players and coaches. The subsystem for informing the public includes the ability to publish the news in any of the websites involved in the system, the ability to publish the documents in the different sections of the documents repository, the possibility of the public disclosure of the results for the each competition and the current team ranking tables, the ability to view the results from the previous seasons of the competition and the opportunity to review the information about the clubs, the teams, the players, the coaches and the referees.

The volleyball competitions in Croatia are organized by many volleyball organizations (or commissions). Each organization performs a part of the overall duties and tasks which altogether ensure the quality of the competition management.

With regard to the aforementioned organizational allocation of the tasks and duties, it is necessary to construct an information system that supports the work of the each functional unit. This was realized by implementing (or it will be implemented) a separate web portal, for each functional unit, that consists of a public part which presents the information to the public and an administration part through which the authorized users can enter the data into the system in accordance to their assigned privileges and by doing so they can perform their given tasks. The system was developed using the modern technologies such as PHP, MySQL, JavaScript, Ajax and etc.

The rest of the article is organized as follows: in the Section II the design process of the system will be explained along with the system’s architecture and the system’s implementation, in section III the functionality of the system is shown, in section IV the usage statistics are shown, in Section V the contribution of Croatian volleyball system will be analyzed, in section VI the possible improvements of the system are analyzed, also the explanation of how the system will evolve in the future is given, finally the Section VII presents a short conclusion of all the things that are presented in the paper.
II. DESIGN, ARCHITECTURE AND SYSTEM IMPLEMENTATION

“The information system is a system that collects, stores, keeps, processes and delivers the information relevant to the organization and the society, in a way that it is accessible and usable to anyone who wants to use it” [4]. The information system is good and efficient from the user’s standpoint if it gives accurate and timely information for all of the queries with the minimal cost and over a long period of time [5].

The Volleyball Information System is based on a three-layer architecture. “The first layer of the information system represents the user interface layer; the second layer represents the business logic layer, while the third layer represents the data layer. The data layer consists of the data stored in the database that is archived by the database server. The business logic layer implements the business logic of the information system and acts as a link between the data layer and the user interface layer. In the observed case, the business logic layer is achieved by using an application server wherein the business logic and the data processing logic are realized. As a rule, the data layer must not communicate with the user interface layer, and vice versa communication is also not allowed” [6].

The three-layer architecture of the Volleyball Information System is implemented through the LAMP platform. The acronym LAMP represents a set of software tools designed for the dynamic Web applications and the web servers [7]. The components of the LAMP are: Linux as the basic operating system and the server environment, Apache as the web server that intercepts the HTTP requests and independently processes and forwards them to the PHP interpreter for further execution, MySQL as the relation database management system that is used to store data and, finally, the PHP interpreter which analyzes and executes PHP code and returns the results to the web server. Fig. 1 shows how the LAMP works. In the first step, the user opens a web browser on his computer and requests a web page. Based upon the inserted address, the user's web browser sends the HTTP request to the server. The server that handles the HTTP requests perceives that the requested file name ends with " .php " and forwards it to the PHP interpreter for processing. The PHP interpreter analyzes the file and executes the code within PHP tags. If analyzed PHP code contains a query to the database, a PHP client opens a client connection to the MySQL relation database management system and requests query execution. Responses to that query are sent back to the PHP interpreter. Once the PHP code execution has finished, the result is returned to the server. Finally, the server returns a response to the received request that is sent to the user's Web browser (usually in the form of an HTML file).

The above mentioned technologies and some other technologies used for implementing the Volleyball Information System are described in the next subsection.

The Volleyball Information System consists of a central database and a set of web portals. Through the web portals the information is distributed to the interested public, while through the portal’s administration part it is possible to enter the presented data into the system. Fig. 2 illustrates the above mentioned system structure.

A. Used technologies

The Volleyball Information System was developed using the following modern technologies: Apache (a web server), MySQL (the world's most popular open source database software [8]), HTML (a language for describing web pages [9]), PHP (a scripting language for making dynamic and interactive Web pages, that is executed on the server side [10]), JavaScript (a scripting language for making dynamic web pages, that is executed in the client web browser [11]) and Ajax (technology that allows a change of a part of the web page content without reloading the entire page [12]). Some of these technologies will be explained in the following subsections.

1) PHP

PHP is a widely used general purpose scripting language that is most suitable for web applications and can be integrated into the HTML code [13]. The primary purpose of the language is to enable the Web developers to quickly create dynamically generated web pages. PHP is the language that connects the complex business logic with the mostly static web presentations [14].

2) MySQL

MySQL is a good system for the multiuser relational database management [14]. Today it is the standard for storing the data that is displayed on the web pages. It is freely available under the GNU General Public License.

3) JavaScript and Ajax

JavaScript is a scripting language for managing the web page functionality on the client side computer. The most important features of JavaScript are the ability to react to events, the ability to read from the HTML documents and to write in them during the run-time.

JavaScript has experienced particular success when the Ajax (asynchronous JavaScript and XML) was created. "Ajax is a group of the interrelated web development methods used on the client-side to create interactive web..."
applications” [15]. Using Ajax Web applications can asynchronously exchange data with a server, and update parts of a web page - without reloading the whole page [12].

Note that Java and JavaScript, except the name and a few key elements inherited from the C programming language, have nothing in common.

B. Database

The database is the central place of the information system [5]. During the design of the information system it is essential to pay attention to the definition of the data structures. A necessary precondition for the effective organization of the data processing is an efficiently designed database, that is adjusted to the processes and the system functions it describes [5]. The user requirements about the information system that is about to be built should be extracted through the requirements engineering process. It is important to determine which entities the information should be recorded about and how these entities are interconnected. Often, the database design begins by developing a schema using an E/R (Entity-Relationship) or object-based model, than translating the schema to the relational model for implementation [16].

Based on the requests extracted through discussions with the future users of the system, it was determined which entities participate in the system and what are the natural links between them. In accordance with the received information the E/R diagram was created. The central place of the created E/R diagram is the received information the E/R diagram was created. The natural links between them. In accordance with the future users of the system, it was determined which entities participate in the system and what are the natural links between them. In accordance with the received information the E/R diagram was created. The central place of the created E/R diagram is the match entity. The match is played by two teams (the home and the away team). The match belongs to a particular round of a particular competition. Each match can be arbitrated by one or more referees, depending on the rank and the rules of the competition. The match is played in a particular sports hall. The rank of each referee is recorded (city, county, national, international). The age category and the information about the club the team belongs to are recorded for each participating team. Also, a list of players who have the right to play for the team and a list of coaches that train the team are recorded per each team. The role in the team (head coach or assistant coach) and the professional qualifications of every coach are noted as well.

An important entity that provides distributed organization of the competition is the region entity. By connecting the competition with this entity, the selective presentation of the competitions and everything connected to them exclusively on the web portals of the volleyball organizations, that organize a specific competition, is enabled. Except the entities required to record the data strictly related to the competition, the E/R diagram contains the entities related to the other Volleyball Information System tasks. The examples of such entities are the following entities: news, documents, pictures, photo albums and books.

Because of the E/R diagram complexity, it will not be presented and described in details in this paper.

Based on the designed E/R diagram, the relational database schema with 46 relation schemas was created (43 physical and 3 views). The created database fully satisfies the existing users’ requirements.

C. Web portals included into the system

The Volleyball Information System includes several web portals of the different volleyball organizations.

The files that the websites of the Volleyball Information System’s components consist of are fundamentally divided into two groups: the common scripts for all the pages containing the basic logic of the system, and the configuration files and the files, which describe the layout of the pages, that are specific for a certain page. Common scripts are located in a folder independent of any of the websites connected to the system while the configuration and the layout files are located on the server space of a specific website.

Both file types are divided into two categories: the public part and the administration. Common scripts in the category of administration are used for data manipulation (inserting, updating, deleting), and scripts in the public part category are used for the review of the data on the public part of the certain websites. Among the common scripts there are several files with specific functions that abstract the specific processes.

Files specific to a particular website stored in the folder administration contain the configuration files that are used to edit the display of the administrative pages. Files for the public part of a particular website are stored in the folder public part and contain configuration files that are used to display public pages. Both categories use a common configuration file that contains common data for the whole website (information for establishing the connection to the database, the URL of the documents and the pictures repository, the standard user messages, etc). In both maps there is an index.php file that is loaded when the browser requests the loading of a certain section of the page. Fig. 3 shows the organization of the files within a single website.

The branching on sections within the every category is done in the file index.php. The data required for branching is sent to the URI as a query and is retrieved by the HTTP GET method. Based on the information about the chosen section, a specific configuration file for the appropriate section is loaded, and then the scripts for the display of the data, which are sometimes intended for more sections, are called.

Fig. 3. The organization of the files within a single Volleyball Information System’s website
III. SYSTEM FUNCTIONALITY

The Volleyball Information System functionality is manifested through the websites included in the system.

The websites can be divided into two sections: the websites of the organizations that directly organize volleyball competitions and the websites of the organizations that are important for the conduct of the competition, but by itself do not organize the tournaments (the Croatian volleyball coaches’ association and the Croatian volleyball referees association).

Regardless of the previous division, all the websites contain the public part, where the desirable information is distributed to the interested public, and the hidden (protected) administration part where the authorized users can enter the data into the system in accordance to the granted privileges, after they have successfully completed the authentication procedure.

A. Web pages of organizations that directly organize competitions

1) The public part

The websites of the organizations that are directly organizing competitions are based on the games, i.e. on the competitions that the organization is organizing. In the central part of the home page there is a list of games that are scheduled to be played within the next three days and a list of games that have been played in the last three days with the corresponding results (Fig. 4).

In the left menu there is a list of the competitions. By clicking on the name of the individual competition, the pages, which contain the competition table with the current rankings of the teams in the competition and the game schedule of the selected competition, are opened (Fig. 5). Alongside the postponed matches their reschedule is listed, while alongside the played ones the result is listed. By clicking on each game more details about the match are presented. Such details include the match start time or the information about the sport hall where the game is played, a list of referees who arbitrate the match and the result if the game has been already played.

In the top menu row there are links to these sections: home, contacts, calendar, clubs, teams, referees, delegates, rules, forms, and archives. In the sections clubs, teams, referees and delegates there is a list of the relevant entities. The information about that entity is shown by selecting a particular entity from the list. For example, by clicking on the name of a specific team a page with the information about the team is opened, which includes: the name of the team, the home sport hall, the category, the sex and the name of the contact person. The team photo, the list of players and coaches and the list of all the matches that the selected team has played, or it is scheduled to play in the current season, are presented for each team (Fig. 6). The categories rules and forms are used as repositories of relevant documents. The results of the previous season’s competitions are available in the section archives.

2) The administration part

The authorized users are the only ones that have the access to the administration part of the site. They are given access to it after they successfully complete the authentication process. The authentication is carried out by using the user name and password. Fig. 7 shows the administration interface of the Croatian Volleyball Association’s website. Sections related to the competitions are placed in the top menu, while other sections are
located in the left menu.

a) The section competitions

The supported competitions include the league, the cup or the hybrid competition. The hybrid competition can be divided into the subcompetitions which are by itself either league or cup competitions. Each subcompetition of the hybrid competition is defined as a separate competition. For example, in the first part of the competition teams are divided into several groups within which they play a league system competition, while in the second part of the competition the best teams from each group will play the elimination type of the competition, in other words the cup system competition. In this example it is obvious that the mentioned competition consists of several subcompetitions. The number of the league subcompetitions equals the number of the present groups, while only one cup competition starts after the group phase. This series of events must be linked in a way which corresponds to the order of the subcompetitions that should be displayed in the public part. Group A would be the first competition in the series (does not continue any competition). Group B follows the group A and it is its subcompetition. Group C following the Group B, etc until the group n (n is the number of groups) that would be followed by the cup subcompetition. The separate subcompetitions that are linked in this way complete a hybrid competition. The mentioned example is illustrated by the Fig. 8.

Through the competition section the new competitions can be made. When a new competition is being made, it is necessary to determine whether it is a simple league, cup or a part of the hybrid competition. For each subcompetition of the hybrid competition except the first in a series, it should be specified which competition it follows. The type of competition (league or cup) should be determined for each competition (or subcompetition). For the league competition it is necessary to choose one of the three offered ways how ranking tables can be calculated. The ranking tables are dynamically generated based on the chosen method of calculating them and on the entered results of the matches. All the teams participating in the competitions should be specified with the draw obtained numbers. According to the numbers assigned to the each team, the competition schedule (all matches) is generated by the Berger’s algorithm [3].

In addition, for each competition the possible referee’s roles (the role and number of referees) depend on the competition’s rank), the list of referees and the dates when each round is played can be specified. It is possible to attach a photo album and a few documents (usually rules of the competition) for the each competition.

b) The section matches

The section matches is intended for the entry of all the data related to the games: the teams that play the match, the competition, the round, the time and place of playing the match, the referees and the match result. The entering of results is the most time sensitive part of the system. Because of the high public interest, it is important that match results are entered and published as soon as possible. Because of that, a simplified form only for the purpose of entering the match results has been created. Competition manager, i.e. the person responsible for collecting the match results and their input into the system is at the time of the occurrence of competition often "on the ground", i.e. he is not at the computer. To facilitate the match results input in such situations, an administration interface customized for mobile phones has been made (Fig. 9). The interface is extremely simple and only match results can be entered through it and only for the matches that have been played in the past 24 hours. This solution provides a better user interface visibility on the small screens of the mobile phones. Also, the required network traffic consumption is reduced. That is important because mobile access to the Internet is still significantly more expensive then the fixed broadband access [17] [18].

c) The sections teams and players

The data about the teams and the players is entered through the sections teams and players. It is important to note that the individual player can be connected with one or more teams through these sections, i.e. for one player the data which determines the teams he plays for can be entered. In the general case it is common that one player perform only for one team, but sometimes younger players perform for more club teams. For example, a player can simultaneously play for the junior and the senior team of the same club.

d) The sections clubs, sports halls and referees

In these sections the information about the clubs, the sports halls and the referees is recorded. The data like the address of the club, the sports hall or the referee, the referee rang etc. is recorded as well.
e) The section news

In the news section the authorized users can publish the news in any of the news section on any of the websites involved in the system, but only in those the currently logged user has the adequate privileges of access to. For example, through the administration interface of the Zagreb’s Volleyball Federation website it is possible to publish the news on the website of the Croatian volleyball association, if the currently logged user (except the privileges of access to the administration section of the website of the Zagreb’s Volleyball Federation) has the right to access the Croatian Volleyball Association website, too. This option was introduced after it was obvious that there is much news that should be published on multiple web portals involved in the system. This way, it is enough to write the news once and to choose which sections of which portals it should be published on. It significantly simplifies the process of publishing the news in more than one portal.

f) The section documents

In the section documents, documents management in the repository of documents is enabled. The documents are arranged by folders.

g) The section photo gallery

In the photo gallery section a new photo album can be created and pictures can be added to the available photo albums. The photo album can be attached to the club, to the team, to the player, to the coach, to the referee, to the sports hall, to the competition or to the match.

h) The section settings

In the section settings various system settings can be set such as: defining the new document folder, defining the new news section, defining the possible referee’s roles, defining the possible player positions in the court, etc.

B. Web pages of organizations that do not organize the competitions

Websites of organizations that do not directly organize the competition will be shown on the example of Croatian volleyball coaches’ association website.

1) The public part

The public part of the Croatian volleyball coaches’ association website consists of a home page where the news are published, a section with a list of the members where by clicking on a single member you can get the detailed information about him, a repository of documents and a titles library. The titles library is designed to support the coaches in their exchange of the expert literature and will be further described below.

a) The titles library

The titles library is designed to support the coaches’ easy exchange of the expert literature. Through the titles library coaches can publish the information about expert books they possess. When one of the colleagues needs an expert book, he can find it in the titles library. If he finds the requested book, by clicking on the desired book title more extensive information about the book will appear. The information includes the name and the surname of the owner of the book as a link to his member profile, i.e. to the place where you can find owner’s contact information (Fig. 10). In this way it is possible to contact the owner and to negotiate with him the literature exchange.

2) The administration part

The administration part of the Croatian volleyball coaches’ association website can be divided into two parts: the part which only the Croatian volleyball coaches’ association employees can access and where they can add the news, add the documents to the documents repository and edit the data about all the members (the coaches) and the part which each member can access and through it can edit the information about himself and add his own books into the titles library.

To gain access to the administration part of the website, the users must be authenticated by using their username and password.

IV. SYSTEM USAGE STATISTICS

Volleyball Information System has been used from the 31st of August of 2009. From the beginning of its work to the system have been connected the Croatian first volleyball league clubs association’s website, the Zagreb’s volleyball region club association’s website and the Zagreb’s volleyball federation’s website. In the beginning of the September of 2010 to the system has been connected the Croatian volleyball coaches’ association’s website. Because of the changes in the management structure of the Croatian volleyball, i.e. the establishment of the new national volleyball federation, from the 1st February of 2011 the Croatian first volleyball league clubs association’s website has been closed, and their function was taken by the Croatian Volleyball Association’s (newly formed national volleyball federation) website. Despite the changes in the volleyball leadership, the Volleyball Information System has continued to successfully operate. The highest average number of visits in the current system’s work has had the Croatian first volleyball league clubs association’s website. The mentioned site in 2010 was loaded 737 472 times, i.e. in the average day this website was loaded more than 2 000 times. The maximum of visits has occurred on the 8th of November of 2010 and it was 7 289 loadings [19].

A closer analysis of the visits to the sites shows peaks in the days when the matches are played, or when the public waits for the publication of the match results [20]. The Fig. 11 shows the number of the unique visits of the Croatian first volleyball league clubs association’s website in the February of 2010. The peaks (the prominent attendance increase) are visible on the graph during the days when the public waits for the match results (Saturday, Sunday and Monday). A similar phenomenon can be seen on the graph of the visits for the entire year

Fig. 10. The titles library
The similar phenomena can be seen at the Zagreb’s volleyball region clubs association’s website or at the Zagreb’s volleyball federation’s website, but with a lower average attendance. The Zagreb’s volleyball region clubs association’s website in 2010 was loaded 190,367 times, the average being 520 times per a day [19]. Zagreb’s volleyball federation’s website in 2010 was loaded 142,952 times, an average of 390 times per day [19].

The Croatian volleyball coaches’ association’s website is not strictly associated with the competition and therefore their attendance does not vary considering to the previously explained rules. In the last quarter of 2010 this website was loaded 9,922 times, making the average 80 times per a day [19].

The Volleyball Information System solves all the mentioned problems. Every volleyball organization through its website, included in the Volleyball Information System, presents its work to the public. The results of all the competitions, starting from the county youth competitions all the way to the finals of the senior Croatian Championship, can be traced through the websites of the competitions’ organizers.

All players are recorded in a single register and the possible multiple registrations of the same players are quickly and easily visible.

The competition management is significantly simplified with the use of the competition management subsystem. At the start of the league competition, the competition manager should enter teams and their by draw assigned numbers into the system. Based on this, the system will generate the competition schedule (all the matches to be played). For the each played match, the competition manager should enter the result. Based on this, the system will generate the current team standings table.

### VI. POSSIBLE IMPROVEMENTS AND FUTURE WORK

The Volleyball Information System has been designed in a way that covers all the Croatian volleyball competitions, from youth county-level competitions to the Croatian Championship senior’s finals. For precise monitoring of the competition, it is also important to record the data about the entities associated with the competitions such as the coaches and the referees. The designed system enables the described features, but because of the turmoil that occurred in the Croatian volleyball in the last few years, the Volleyball Information System has still not been used to its full potential. All volleyball competitions are noted only for the city of Zagreb. The county-level competitions are published on the Zagreb’s Volleyball Federation’s website, the regional on the Zagreb’s volleyball region clubs association’s website, and the national on the Croatian Volleyball Association’s website. This way, the results of all the matches of all the teams of all the Zagreb’s clubs in all of the Croatian competitions they participate are known (recorded in the system). The situation is somewhat worse for the Zagreb’s volleyball region (excluding the City of Zagreb). Through the Volleyball Information System competitions are recorded starting from the regional-level of the competition (there are no information about the county-level competitions). For the rest of the Croatia only the information about the competitions at the national level is recorded. Fig. 13 graphically shows the level of the involvement of the certain Croatian counties in the Volleyball Information System. The black color marked area is the one that is fully connected to the system, the dark gray one marks the area where the information for the competitions is recorded starting from the regional-level of the competition, and, finally, the light gray marked area is the area for which the data is recorded only for the competitions at the national level.

The main goal in the near future is to add the three remaining Croatian volleyball regions (east, west and south) to the Volleyball Information System and after that all the county volleyball federations. It is important to add the Croatian volleyball referees’ association’s website to
the system. In the administration part of that website, an interface for delegating and evaluating the referees would be made. This way, the Volleyball Information System would be connected to all the entities related with the Croatian volleyball competitions. This would ensure a quality public reporting of all the competitions, but also the possibility of the quality control of the entire system of the Croatian volleyball. Also, all of the prerequisites for the introduction of the central registration of the players would be achieved. The county registration authorities would enter the requirements for the registration of players through the appropriate interfaces, and these requirements would be accepted or rejected by an authorized person of the Croatian Volleyball Association Registration Commission.

Through its usual work, the Volleyball Information System collects many interesting data that can be analyzed. Based on this data, it is possible to design a data warehouse. “A data warehouse is a database containing historical fixed data that is collected and processed to support the business decision making” [5]. The collected data can be used for the data mining process. The data mining is an analysis of (an often large) observational data sets with the aim of finding the unexpected links or the display of the data that is new and useful for their owner [21]. Very interesting information can be analyzed based on the data collected in the Volleyball Information System. This information includes the connection between the match length and the teams that play the match or the dependence of the match result based on the court where the match was played (home or away) and etc.

In this case study the performance of the system is not specifically considered. Security of the system is based only on authorization. In the future, improvements to this system should be focused on the non-functional requirements of the system, such as performance and security.

VII. CONCLUSION

The Volleyball Information System was conceived as an information system for the Croatian volleyball. Its task is to record the information about all of the Croatian volleyball entities and the processes in which they participate. It is composed of a central relational database and a set of web portals belonging to the different volleyball organizations. Through its own web portal, each organization presents its work to the public. Through the specific administrative interfaces customized for each organization that is involved in the system, the authorized users of the each organization can enter the information, related to the tasks performed by their organization, into the central database. This way, the centralized and the structured data storage system for the entire Croatian volleyball is achieved.

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