Design and Implementation of the Medical Equipment Traceability and Declaration System

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Abstract. There are many problems in the production, circulation and the usage of medical instruments in Chinese medical instrument industry, especially the problems in circulation. In this paper, I developed the medical equipment traceability system by PHP based on the current status of medical instruments in the circulation. Meanwhile I developed the function of evaluating the quality of operation relying on the relevant data of the system, combined with TOPSIS algorithm of the comprehensive evaluation. Through this function, the patient who has the will of surgery can know the analysis of the evaluation in the quality of operation based on some kind of medical instruments in some kind of hospital.

1. Introduction
Recently, with the vigorous development of our country’s medical treatment, the people's demand for medical instruments is getting higher and higher. But meanwhile, we should realize that there are many problems in the process of production, circulation and usage of medical instruments in the medical equipment industry in our country. And the problem of circulation is particularly prominent. At present, the traceability of medical instruments is often concentrated on the production and usage of the instruments, ignoring the problems existed in the circulation of the equipment. It is very necessary to build the traceability system for the circulation of medical instruments. The quality of the operation has a great impact on the healing and recovery of the patient. In order to cure their disease in time, patients with the desire of operation need to know not only the quality of a hospital but also the quality of surgery services. At present, there are many researches on the evaluation of hospitals quality, but the evaluation on the quality of the operation is less. Building an evaluation system of quality based on correlative data of the medical instruments and getting the results of evaluation of surgery in different hospitals based on the model of evaluation will provide an evident reference for patients undergoing surgical selection.

The system adopts the open source language PHP, which is very convenient and quick to the process of the database, and has high development efficiency. The system also elects the MySQL as the database, which has a feature of small size, high efficiency and very low cost. PHP can use the API function library provided by MySql to realize various operations on the database. As a whole, the system is developed with XAMMP (PHP+Mysql+Apache) integrated environment.

2. The Design of System

2.1. The Design of The System’s Module
Based on the requirement analysis of the function of medical instrument traceability and evaluation of surgical quality, the system is divided into the module of medical equipment enterprise, the module of
the Food and Drug Administration staff, the module of system administrator and the module of patient with the operation intention. The overall structure function diagram of the system is shown in Figure 1.

![Overall structure function diagram of the system](image)

**Figure 1.** Overall structure function diagram of the system

The diagram shows the module division and the organizational structure of the system. The specific functions of each module are as follows:

- The module of medical instrument enterprise. This module targets medical instrument enterprise. Through this module enterprise can accept the relevant notification about the result of examining medical instruments from FDA staff, maintain basic enterprise information, manage the medical instrument which the enterprise operates, collect and declare the supplying information and the sales information of medical instruments.

- The module of Food and Drug Administration staff. This module is aimed at Food and Drug Administration staff. Through this module FDA staff can consult the medical instrument supplying and sales information of each medical equipment enterprise, examine the medical instrument which enterprise declares (the acceptable instrument can enter the basic database of medical instrument) and maintain the basic database of medical instrument.

- The module of the system administrator. The target of this module is system administrator. Through this module system administrator can create new and different types of users, allot authority based on different types of users, delete and modify the basic information of all users, manage the system log and add a new module when the users have new demand.

- The module of the patient with the operation intention. This module targets the patient with the operation intention. Through this module the patient can search for hospital which he is interested in, check the radar chart of the evaluation index of the quality of surgery about a certain medical instrument in a certain hospital, and look at the bar chart about the order of surgical quality evaluation of the certain instrument at a certain hospital.

2.2. The Design of Database

In this paper, 17 tables have been created in the MySQL database. These tables involve the function of collecting supplying and sales data of medical instruments, declare the supplying and sales data by enterprise, consult the data of medical instrument by FDA staff, examine and approve the medical instrument and check the order of surgical quality evaluation. The creation of the tables follows the principle of a table that corresponds to the information of an entity or object. These data tables cooperate and realize the relative functions of the medical instrument traceability and declaration system. Limited by the length of paper and the most entities containing more fields, there is only an
example of an entity connection diagram when administrators set up the modules. The entity connection diagram between administrators and modules is showed in Figure 2; other diagrams of entities are omitted. This diagram can reflect the relationship between the entity of administrator and the entity of module. That is to say, an administrator can set up multiple many modules and a module can be set up by many administrators. The administrator entity includes three attributes: administrator ID, administrator name, and administrator state. Determining which administrator set up the module by the administrator ID. The module entity includes five attributes: module ID, function description of module, module state, and module name and change time of module. The module ID is used as the primary key to determine which module is set up by the administrator.

![Entity connection diagram between administrators and modules](image)

**Figure 2.** Entity connection diagram between administrators and modules

### 3. The Realization of the System Function

#### 3.1. Key Technology of System Implementation

3.1.1. *The Technology of Smart Template.* This system uses the Smarty template technology of PHP to accomplish the implementation of system. Smarty is the most powerful and famous template engine which written by PHP. The Smarty template engine is very suitable for the Web system based on the MVC mode. Smarty template makes the logic of the program separate from the external content. That is to say, separating PHP from HTML, making programmers and art designers develop at the same time. Smarty template file actually includes a few simplified PHP codes. If the art designing page is specified as a template file, it is only necessary to define the dynamic content in the page as variables and put these variables in the corresponding position of the template file. The dynamic content includes the output of database and interaction of users. When users browse, the template file is invoked by the PHP program file, and the variables defined in the template file are replaced, and then a complete page can be output. In this system, all the pages which can be displayed are template file forms.

3.1.2. *The Technology of Generating Chart.* In this system, the patients who have the intention to have the operation need to see the radar chart and the histogram about the evaluation of the surgical quality. The system uses the Fusion Charts tool to realize the function of checking chart. The steps to realize the function are relatively simple. First, we should put the Fusion Charts.js files and the .swf files of the different types of charts that the system need into the project. The FusionCharts.js file is include in
the page that needs to display the chart. Then founding the Fusion Charts object by JavaScript. The object which was founded will be responsible for connecting the swf files which are used to display charts and data source to be shown by charts. The data source is obtained through the set Data URL method of the Fusion Charts object. This method points to the URL of the XML document containing the chart data. Finally only providing the URL of the XML file.

3.2. The Realization of The System’s Login Function

Four types of users included in this system are the user in medical equipment enterprise, the user in Food and Drug Administration staff, the user of system administrator and the patient with the operation intention. Different users are distributed to different access to the system for them when they log in the system. Users input their username and password when they use the system at first. After the users click on the login button, login method will package the username and password as a string called result. Then the system will get the information of user’s access based on the field of user_id. Next, the system will package the information of user’s access and password as a string called token and send the request of login and token through the protocol of HTTP. When the server receives the request of HTTP, the server will execute the instruction of SQL. Then the server will judge the user's legitimacy based on the authenticity of the token and the user’s type. If it does not exist, return to null. If the user exists, it returns to 1, and the user jumps to the interface that corresponds to its own authority.

3.3. The Realization of The Main Module of The System

A major distinguishing feature of this system is using the data of medical instrument’s supplying and sales and the relevant data of hospital which is collected to realize the function of the evaluation of surgical quality. In order to achieve the evaluation of the surgical quality, first of all, obtain the evaluation index of surgical quality by consulting relevant literature and quality standards. The evaluation indexes of surgical quality have five First-level indexes: human Resources of hospital, status of medical instruments, quality of diagnosis and treatment, cost in surgery, patients’ satisfaction. The five first-level indexes can be subdivided into twelve secondary indexes. Due to the large number of indexes, only giving the table about the index of medical instruments’ status. The index of medical instrument’s status is shown in table 1. The data of medical instrument’s status is all from the medical instrument traceability and declaration system. Rest of the data is from the database table of the third-class A hospital in Hebei Province. The evaluation of the surgical quality is based on the TOPSIS algorithm in this article. The TOPSIS algorithm is commonly used in the comprehensive evaluation of the medical field, and the flow chart of the TOPSIS algorithm is shown in Figure 3. Substituting the index data obtained in the previous article into the TOPSIS algorithm and getting the weighting decision matrix. Using the weighted decision matrix to obtain the positive and negative ideal solution of target which is be evaluated. Calculating the positive and negative distance between the evaluation target and the ideal value. Calculating the relative pace of each evaluation target. Finally, we get the objective and reliable ranking of the comprehensive surgical quality’s comprehensive evaluation of the different hospitals in certain medical instrument. The patient who has the intention of operation can see the histogram of the comprehensive evaluation of the service quality by clicking on the operation evaluation of the comprehensive sorting button.

| First-level index          | Secondary index                          |
|----------------------------|------------------------------------------|
| Medical instruments’ status| The proportion of imported medical instruments |
|                            | Medical equipment sampling pass rate     |
|                            | The usage of extensive degree of medical instruments |
4. The Test Of System
As the key step to ensure the stability and reliability of the system, system testing is the last part of the system creation cycle. In this paper, the test of the system includes two aspects: Testing the functions of each module of the system and test the compatibility of the system in different browser environments. In the test of system’s module, the main test is whether each function module of the system can be used normally. And I test whether the input and output of each module are normal. In the test of the system’s compatibility, testing all different pages’ compatibility in environment of IE, Firefox, Safari. Testing whether the different pages can be displayed normally in different browsers. After many tests, the system behaves well.

5. Summary
The author analyse actual demand of all kinds of users, completing the design and development of medical device traceability and declaration system by PHP and MySQL and developing the function of evaluation of surgical quality based on the data of medical devices ‘status of this system. The usage of the system is simple and the interface and the hint of the text of the system are easy to understand. To some extent, the system has solved the tracing problem of medical devices in the process of circulation. At the same time, it is convenient for the patients who have the intention of operation. Providing reference of the evaluation of the surgical quality in each of hospital when they want to do the operation.

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