Quality evaluation information system of street cleaning

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Abstract. The problem of increasing the effectiveness of measures aimed at the effective implementation of public utilities in a modern urban environment is being addressed. The main task is to control the quality and efficiency of work performed. Timely street cleaning is hindered by many factors, including the lack of a unified automated information system for evaluating the work performed. This approach will allow you to combine high performance due to the speed of the system and effective quality control of street cleaning. The aim of this work is to study and analysis of existing information systems, allowing to automate the process of quality control and operational execution of the challenges described above. On the basis of the conducted research, develop an information system, agreeing with the customer (administration of the Central district of Krasnoyarsk) requirements and functionality. The principles of metrological support and operation of measuring equipment are the basis for creating and maintaining the state of automated information system measurements, in which their unity and uniformity is observed. This article presents the main aspects of the design and software solution. The software solution is implemented in the PhpStorm integrated development environment in the PHP programming language.

1. Introduction

Modern city services and organizations operate in conditions of a large volume of constantly changing information that needs to be promptly analyzed and made the right decisions. Objection to this fact, there was a need to design and develop an automated information system (AIS) [1] that automates, controls, evaluates and analyzes the work of urban street cleaning services in the city.

Research and analysis of existing solutions show that existing solutions have a number of disadvantages, among which the most basic is the inability to use them outside the cities where they were developed. So, for example, in Moscow there is a mobile application service “Our city”. This is an Android application designed for residents of Moscow with an active civic position. Users can improve living conditions in the capital, reporting on various situations and problems on the streets. The main objective of this application is to collect and send complaints from residents about various urban problems to the relevant authorities. In this service, you can inform the authorities about breakdowns in yards, houses, on roads and much more. Additionally, users can report illegal placement of objects. Note that users are notified of troubleshooting. For this, several special sections are provided.

As we have already previously described, the main drawback of the above service is its territorial attachment to a single city. In addition, users of this service highlight the following disadvantages:
Too limited list of topics to choose from (less than 10).
There is no possibility of feedback on an already added case.
A lot of requests are rejected by moderation for an unknown reason.
Problems with specifying the address of a resident (incorrect stored addresses in the database).
Most of the problems have not been solved, and there is an endless postponement of work deadlines.
When updating the application, the entire database of registered users is erased (existing accounts, contact and message history, etc.).

In addition to the domestic service, a foreign analogue of the Los Angeles Clean Streets Index street control system was considered, which uses the ArcGIS service (ArcGIS Online is a comprehensive solution for mapping and analysis).

The Los Angeles clean streets index (the first of its kind) is a system of ratings for every street in Los Angeles. The Sanitation Bureau drove and scored more than 9,000 miles of streets and alleys - each segment received a “cleanliness rating” of 1-3. Each street score is based on four factors: trash, weeds, bulky items, and illegal dumps. This estimate will be repeated every quarter. Los Angeles leads the way as the only major city in the United States that regularly evaluates the cleanliness of every street in the city. Clean Streets LA provides a new funding for the hiring and training of additional sanitation teams that respond directly to cumbersome pickup requests and illegal dumping messages. It means that there will be more workers on the ground for timely cleaning in areas where they are most needed. The disadvantage of the above described system is its inability to adapt and use outside the city where it is used.

The development process of the AIS considered in this article provides for the drawbacks of existing similar services, and at the design stage, additional functionality was proposed, which is described below.

2. Methods
The design of any information system (IS) [2] is subject to the basic principles of software engineering [3], which should be taken into account in order to improve the quality and speed of development. When creating AIS, the task of distributing roles and tasks performed by each user in the system is solved. The system under development involves the use of several levels of access rights with the corresponding capabilities for working in this system.

The key task in this work is to take into account all the customer's wishes in an optimal way, and at the same time comply with the normalized requirements for the development of such systems. Objection to this fact, a design solution for use-cases is presented for users of various levels to work with the system (figure 1).

Figure 1. Users with different roles in the system.
In addition, at the design stage it is necessary to provide a system of access rights. This system allows you to describe sets of rights that correspond to the positions of users or type of activity. The structure of rights is determined by a specific application. To implement the restriction of access rights in application solutions, special objects are designed - Roles. The role determines what actions, on which metadata objects, the user acting in this role can perform. Below is a design solution for use-cases for users of various roles with the system (figure 2). This aspect makes it possible to understand how the participants in the process act and thereby determine their interaction and impact on the process. To build process models within this aspect, Use-case diagrams [4], sequence diagrams, collaboration diagrams, and action diagrams are used.

Figure 2. UML-use case diagram.

At the moment, the design of the database [5] (DB) for the created AIS is presented, its structure and objects are defined (figure 3). This diagram shows that the system currently provides a distinction between user roles. The functionality that is available for each user role in the system is visually presented.
Figure 3. Diagram of the database being developed by the AIS.

3. Software implementation

The development environment PhpStorm was used for the software implementation. This commercial cross-platform integrated development environment for PHP from JetBrains is powered by the IntelliJ IDEA platform. PhpStorm is an intelligent editor for PHP, HTML and JavaScript with the ability to analyze code on the fly, prevent errors in code and automated refactoring tools for PHP and JavaScript. In this environment, on the designed database and option diagrams, an initial version of the information system for the automated control of street cleaning in the city was developed. The server and logical part code is written in the PHP programming language [6], design and layout in the HTML markup language using cascading CSS style sheets, using the JavaScript scripting language to add interactivity.

In addition, the task was set to display tables from the last five hits with the status of “expired”, so that the user could correctly set their priorities at the beginning of the working day. For users with the “manager” access level, exactly the same information is displayed, but on a larger scale, i.e. Information on all existing problems.

In addition to this, a rating system has been developed. This system will be auxiliary for managers in order to identify employees who, to one degree or another, do not perform work. In the “Problems” section (figure 4), the identified user will have a list of all the calls for which he is responsible. This window opens the form on adding / changing existing problems in the city with the following fields: name, description of the problem, who identified, responsible, address, deadline, date of elimination, work done, attached files (media). To facilitate the search for a specific appeal from all available in the database, employees are offered search filters according to the following criteria: date, name, addresses, performers and responsible.

During the development of the service, the administration of the central district of the city of Krasnoyarsk proposed creating a module in which there will be data export in various document formats.
Thus, under the hit table there is an active “export” button, when clicked it is proposed to select the required document format (Word, Excel, PDF, CSV) for the corresponding export.

![Figure 4. Page for entering pollution problems in the city.](image)

4. **Metrological support**
   The principles of metrological support and operation of measuring equipment are the basis for creating and maintaining the state of AIS measurements, in which their unity and uniformity is observed [7].

   According to the set goal and the set task, the metrological support of the developed IS can include the use of standards, which will be the measuring instruments (MI) in the existing IS: the Our City service application and the foreign analogue of the Los Angeles Clean Streets Index street control system.

   For the initial stage, it is proposed to use the transfer of the size of the units of IS as primary standards, implying a reduction in the size of the measured value of the developed AIS and the standard - MI [8] of existing IS. As one of the measured values, it is proposed to use the average time spent on fixing problems in the application-service “Our City”, classified by topics of treatment, corresponding to problems in the developed AIS. The measurement of the time taken to eliminate the problem and comparing it with the calculated average value in the existing system at the starting stage is an indicator of the efficiency of the work performed. To evaluate the effectiveness of measures, a comparative characteristic of statistical indicators of the Los Angeles Clean Streets Index street purity control system and similar calculated statistical indicators developed by AIS are proposed.

   For the subsequent metrological support, means of measuring the number of applications can also be used, classified by the following indicators: 1) the location of the problem; 2) the cause of the problem; 3) the conditions for the occurrence of the problem (weather, social events, etc.); 4) the time of year the problem occurs. The MI provided serve as tools in the process of quality control of the work performed by the utilities.

5. **Discussion**
   The advantages of the developed AIS include the following:

   - Full distribution of all possible tasks by roles in the system.
   - Automation of the entire process of office process.
   - The connected API of all existing addresses, which prevents users from entering a non-existent address.
   - System performance.
   - Usability (the ability of a product to be understood, studied, used and attractive to the user under specified conditions (ISO / IEC 25010) [9]).
   - Monitoring the work of subordinates.
• The possibility of multi-criteria data filtering.
• The ability to receive reports for any period of time.

Conclusion
As a result of the work, an initial version of the information system was developed for an automated control system for street cleaning in Krasnoyarsk.

In the future, it is planned to design and implement a correlation analysis of the most frequently polluted areas of the city, based on the collection and analysis of statistics on cleaning requests throughout the city, to predict possible problems that may arise soon, based on such parameters as: season, weather conditions, and potentially possible areas of illegal graffiti on the walls, pollution by garbage, etc., as well as for reporting employees of relevant services.

The development and support of full-fledged metrological support of the information system for AIS control of street cleaning in the city of Krasnoyarsk will contribute to solving the tasks to increase the efficiency of measures aimed at the effective implementation of public utilities, improve quality control and their operational implementation.

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