The developing program system of social monitoring of road improvement and urban infrastructure

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Abstract. In the study, there is considering a problem of monitoring and evaluating the operational status of road network. As the main task, there was highlighted the creating a unified informational center providing a possibility of fixing defects in roadway and poor-quality infrastructure and providing an early warning responsible authorities. The suggested informational system let distribute tasks between contractors and track the work efficiency. To solve the task, there was developed a mobile application for data capture by users and web-service for specialists of responsible authorities united to the “IS MRIB” single information center. In the study, there were describing requirements to the system and using software for implementation. There were use-diagram and interface layouts. To justify the advisability of the system development it was a comparing analysis of analogues and distinguishing advantages of the proposed way. Ways of popularizing mobile application were suggested to increase volume of collecting information.

1. Introduction

Nowadays, in Russian cities there are many problems of beautification [1]. It includes poor-quality improvement of municipal facilities work, which affects the general appearance of cities. Wastelands and poor street lighting make a basis for increasing crime rates [2]. But main problems are road surface defects. According to The Scientific Road Safety Center of the MIA of Russia, in 2018 in country there were 59.4 thousand accidents due to deficiencies of the operational status of the road network [3]. Many of these violations cannot be timely resolved because of the lack of awareness of responsible authorities’ employees in concrete hotbed of problems.

Moreover, certain areas require a priority response and complex solution of beautification problems. The main task of informing responsible institutions is creating unified information center providing a possibility of fixing road defects and poor-quality infrastructure with the linking its location to a map and adding into unified database. With the application, responsible authorities’ specialists can timely respond to handlings, see a full picture of detected problems and plan current repair and improvement work better. In addition, the information center allows quickly distributing tasks among contractors and track the efficiency of their work.
2. Methods
During the development of information system, there was chosen the next composition of technical tools and technologies (table 1):

| Purpose                                         | Tool                      |
|------------------------------------------------|---------------------------|
| Programming language for a mobile application  | Swift                     |
| Integrated mobile application development environment | XCode                    |
| Programming language for a web application     | TypeScript                |
| Integrated web application development environment | IntelliJ IDEA            |
| Programming language for server                | Java Script(Node.js)      |
| Integrated server development environment      | IntelliJ IDEA            |
| A database management system                   | PostgreSQL               |
| Distributed version control system             | GitLab (Git)             |

3. Solution description
The task result of the problem is creating a mobile application for the urban infrastructure inspection and a web application for displaying detected problems and providing feedback with responsible authorities united to “IS MRIB” unified information service. In the result of the implementation of the information application, there are the next changes:

- Reducing time of detecting and analysing a scale of road defects and problems in the improvement of urban environment facilities.
- Reducing time of fixing detected violations of urban environment facilities.
- Simplifying and accelerating the process of notifying responsible persons about detected problems.
- Appearing the visibility of the detected problems scale.
- Reducing cost of the urban improvement.

Thus, the developed system provides functionality, which is discussed below.

For citizens:

- Creating a violation card: possibility of choosing a type of a violation; possibility of making a photo of a detected violation in the application; possibility of downloading done photos from mobile storage; possibility of describing details and giving a comment of a violation in the textbox; possibility of specifying a location of a violation manually or automatically.
- Countdown timer to a card if there is scheduled response time or fixing time (for example, a hole on a road must be fixed in no more than 3 working days).
- Sending and confirming.
- Assigning a status to a card.
- Displaying violations in the map from all users.
- Colour indication of violation markers in the map: green is the normative period expires in more than a day; yellow is the normative period expires in less than a day; red is the normative period expires today; grey is the normative period does not exist.
- Viewing the list of sent violations and its status.
- Possibility of agreeing or appealing against a status of a request.
- Viewing received encouragements and its status.

For responsible authority employees:

- Displaying spots of violations in a map from all users.
- Viewing all cards of violations and possibility of changing its status.
- Sending a fixing violation card to the contractor.
- Viewing statistics of users and assigning encouragements.

For contractor:

- Receiving a request for the fixing the problem.
- Notifying responsible authority employees and a citizen, reported about the problem about the implementation of a request.

Use-case diagram of the suggested information system is presented on figure 1.

![Figure 1. UML diagram.](image)

On figure 2 there is an interface of several windows of the mobile application.

4. Results and discussion

In the current time, there are information systems with similar functional. There is comparing software products with the suggested solution in next points (table 2).
Figure 2. Mobile application interface.

Table 2. Comparison analogue table.

|                  | City                  | RosYama                | Spot                   | IS MRIB                |
|------------------|-----------------------|------------------------|------------------------|------------------------|
| Creation initiator | The government of Moscow | Anti-corruption foundation | LLCRSA | MGOMRIB |
| Responsible person for troubleshooting | Moscow executive authorities | Russian traffic police | Russian traffic police | MGOMRIB |
| Regional coverage | Moscow city and region | Russia | Russia | Krasnoyarsk city |
| Point of interest | Fixing problems, associated with roads and improvement for timely response and tracking results of taken actions from responsible persons | Accountability of contractors on roads | Accountability of contractors on roads | Fixing problems, associated with roads and improvement for timely response and tracking results of taken actions from responsible persons. The feedback implementation by dispatchers and the provision of information about activities conducted to solve these problems. |
| Platform | iOS and Android | Web application | iOS and Android | For inhabitants: iOS and Android. For dispatchers: Webapplication |

Questions answered by columns from table 2:

- Who is the initiator of the creating a software product?
Who is the responsible person for the fixing identified problems?
What the regional coverage a software product has to have?
What is the purpose of the creating a software product?
What the platform a software product has to have?

According to table 2, summing up is that in the market most applications are resources of accountability and complaint. Moreover, there is no software products, in which an initiator of the creation is an organization, which is responsible for the fixing detected problems, it complicates feedback. The closest analogues are the “Our city” application, but it serves a current area and it is focused on its features and specifics.

The introduction of the “IS MRIB” informational application has to impact on the sphere of the road management and the urban improvement in several points.

Firstly, the mechanism can allow detecting poor-quality work of contractor before the expiration of warranty time, it will significantly save municipality resources [4]. Nowadays, all state and municipal customers have to set warranty time to road works [5]. Because of large volumes of done works, a customer is not able to check all parts personally or timely process complaints received from citizens in writing. According it, the big amount of poor-quality done works is detected after the expiration of the warranty time.

Secondly, the software can allow establishing feedback between the municipality and citizens. During the solution of detected problems, citizens are able to see a work of responsible authorities. Today there is no tool to show the implementation of their responsibilities by MRIB authorities, that makes a distrust from habitants.

An important problem of the implementation of the type of system is the incentive of citizens to find out problems of beautification. To the functional system, it is necessary to update database regularly. For it, the list of encouragements has been performed for active users in the system. The list envisages different material and non-material encouragements: a public transport privilege, free tickets to museums, invitations to exhibitions, fairs, etc. This way of material and non-material stimulate can allow increasing interest in a project and engage a big number of citizens to surrounding problems as well as it increases the quality of information in requests [6].

5. Conclusion
At the moment, the creating the suggested information application is in demand citizens and responsible authorities. The software product will allow improving the quality of citizen life. Methods of material and non-material stimulating members of the process of an operational road network status let increase an amount of involved people and, as a result, a volume and quality of gathered information. As quality, there are not only characteristics of receiving information but also the geographic coverage of detected violations. In the way, the increasing a number of involved citizens simplifies a collection of needed information for responsible authorities. The quick feedback directed to some operational fixing disadvantages of the road infrastructure is an important step in the way of the forming a clever city [7].

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