Features of Creating of Employees' Working Hours Interactive System

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Abstract
This article analyzes the existing technologies and software tools for accounting of working time of employees, which showed the relevance of the study and identified the main shortcomings of existing approaches. During the research, a mathematical description of the subject area was performed using the algebra of algorithms, which provided the means to minimize the created models by the number of unfiterms, and thus provided the means to display and optimize the system structure. An object-oriented design of the software system was performed, which consisted of constructing a set of diagrams (a diagram of use cases, classes and activities) according to the UML standard. In accordance with the analysis of available design methods and technologies, a system was developed that is designed to visually monitor the working time of the employee and track related parameters. Further research will be aimed at creating additional software modules (payroll, biometric control), their verification and coordination of operation.

Keywords 1
working time, buddy punch, algebra of algorithms, monitoring, project management

1. Introduction

Continuous informatization of society contributes to the introduction of information technology in all spheres of human life. The human resources management industry is no exception, being one of the first to use advances in electronic document management and automatic time tracking in its arsenal. It is worth noting that this transition has brought many benefits to businesses. In particular, according to the American Wage Association, companies can save 2% of gross wages annually by automating the tracking of employee time [1, 2].

We should also not forget that time is a valuable resource of the enterprise, which can be spent on non-official actions or time to perform typical actions is greatly exaggerated, and thus there is a term that characterizes the so-called theft of time (Buddy Punch). In particular, according to HR.com, about 43% of employees exaggerate the amount of their working time in the reports, which contributes to unnecessary costs on the part of the company [3]. In addition to saving the company's money and solving the problem of time theft, the introduction of staff time tracking systems brings a number of benefits, including [4,5]: increased productivity, improved time estimates, improved financial reporting, accurate billing, workload assessment.

Given that, it is important to create a software system with automatic tracking of staff time.

2. Related works

The analysis showed that today the software market is represented by three categories of software solutions for tracking staff working hours, including: time tracker, working time accounting, project management [6, 7].

Time tracker. This software solution allows users to record the start / end time of the working day (block in / out) using their phones or laptops or use a stopwatch to record the start / end of the task. The time tracker also has the functions of analytics and reporting based on consolidated data.

Timesheet. The main function of this software solution is online time and attendance, which is available from desktop or mobile devices. Typically, these software solutions are integrated with the payroll system, or with the billing system.

Project management. Many time and attendance software solutions are part of larger project management information systems. They provide mechanisms for forcing the overall picture of the project, focusing on tasks that can be further divided into many subtasks. These systems allow you to track tasks, determine deadlines, display time estimates and track progress [4].

The analysis of modern software showed that the market of these systems is extremely developed and contains many software: Paymo, Harvest, Tsheets, Toggl, Hubstaff, Timely, TimeCamp, TrackingTime, Time Doctor, RescueTime [8, 9]. Given the mass use, for further analysis were selected: Paymo, Tsheets, Hubstaff.

Paymo is a full-featured project management system with time tracking and accounting functions that help companies manage projects throughout their life cycle [10]. The main window is shown in Fig.1.
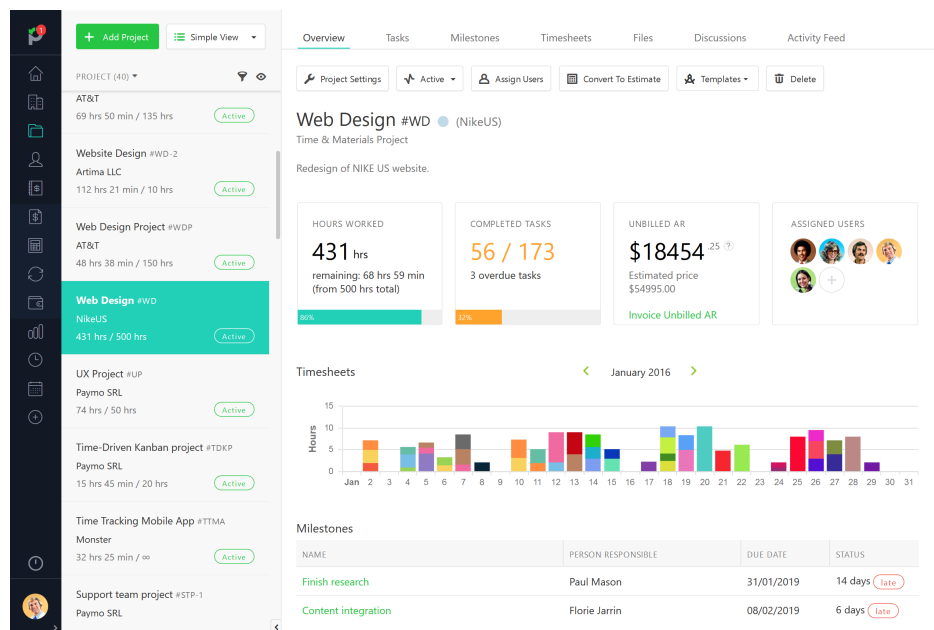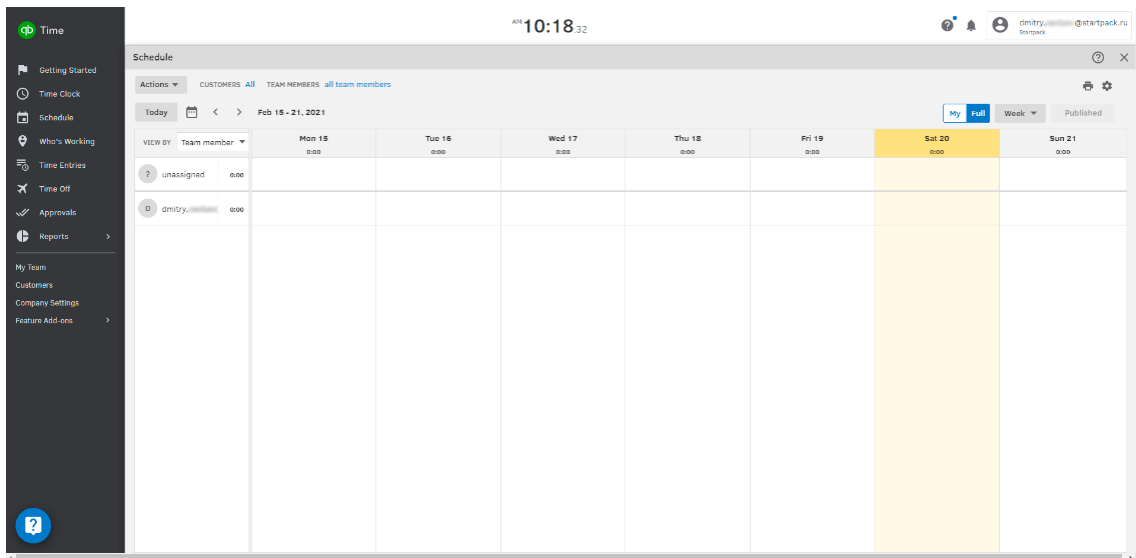

Figure 1: Graphical interface of the Paymo information system

The advantages of the system include: cross-platform (this system is available not only on mobile devices and as a web application, but also as a desktop application with the ability to work offline), resource management and advanced statistics (these parameters provide a broader understanding of what amount of work an employee can perform and what tasks he/ she copes with better, which will help in planning the next projects), automated accounting and integration with various payment services. Among the disadvantages, the analysis showed that to track working hours, the system uses an employee desktop analyzer. Although this solution provides a reliable mechanism for tracking working hours, it can cause a problem of employee privacy when using this system.

TSheets is a cloud-based solution to help executives track employee time in real time. The service exists both in the web version and on mobile devices, which provides tools for use regardless of the location of the employee. The main window of the system is shown in Fig.2 [11].

Figure 2: Graphical interface of the TSheets information system

In TSheets, an employee can set up overtime notifications, which are sent by text message within the service or by e-mail. For management, TSheets includes a cost management module that provides detailed information on current and planned project costs. The benefits of the system also include change planning tools and time-based functions (Time Clock Kiosk). Disadvantages include the commercial use and means of photographing employees while performing a task, which to some extent violates privacy requirements.

Hubstaff is a time tracking system with the functions of capturing screenshots, monitoring work, automatic payroll, real-time tracking and GPS [12]. The service integrates with more than 30 popular tools and is suitable for remote teams and small businesses (Fig. 3).
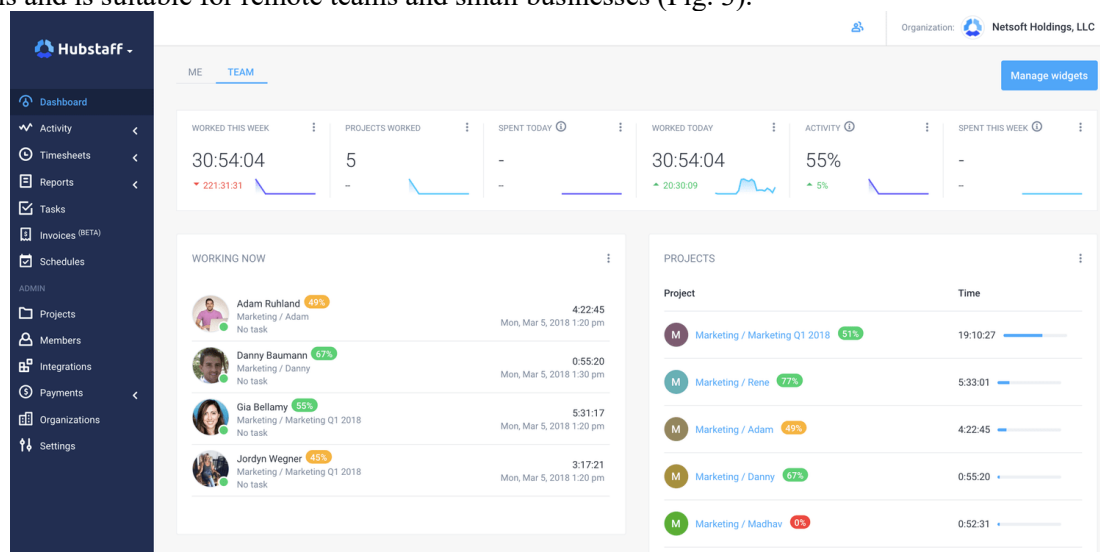
Figure 3: Graphical interface of the Hubstaff information system

The main features of the system are: formation of activity levels, providing separate levels of access for users, tracking the time of remote teams, integration with PayPal and Payoneer payment systems for self-calculation of wages, viewing used programs in the team in real time.

The analysis showed that the available software has one significant drawback, namely to ensure the reliability of the input data, they all partially violate the privacy of employees, using the monitoring method of tracking working hours (photos of employees - Tsheets, desktop images - Hubstaff, Paymo). can demoralize the latter. Given that, an important task is to create a system for tracking the working hours of employees.

3. The main objectives of the study and their significance

The aim of the study is to design a system of interactive tracking of employees' working hours, which would not violate their privacy and would be competitive in the market of commercial systems. The study will provide tools for interactive display of the workload of an individual employee, and thus contribute to the even distribution of workload among team members.

To achieve this goal it is necessary to solve the following main tasks: to analyze existing approaches and software tools used in the field of download tracking; identify the main tasks that arise, build models according to which you can carry out this process and programmatically implement the described approach in the created software.

The results of the study solve the current scientific and practical problem of creating software for monitoring the process of effective organization of working time.

4. Material and methods

An analysis of known tracking technologies has shown that there are currently two main approaches that can be used to maintain privacy, namely, location-based automated tracking and using the Raspberry Pi minicomputer. As for the first technology, in contrast to the other, it has the following disadvantages: inaccuracy of the GPS system in the office (GPS system may malfunction or in some cases not work at all, due to interference created by buildings), energy consumption on mobile devices (for this tracking method to work, the mobile device must be constantly turned on GPS and Internet access, which significantly increases power consumption and reduces the battery life of the device), vulnerability to hacking (this method is relatively easy to hack using root privileges) access on the mobile device, allowing you to change the location of the mobile device for applications running on it). As for the second approach, the use of Raspberry Pi resources will provide the means to organize support for the Secure Shell protocol for secure remote login and secure actions by transmitting data through an unsecured environment [13]. Given these shortcomings of the location-based time tracking method, it was decided to automatically track using a Raspberry Pi mini-computer.

5. Experiments, results and discussion

Further research was aimed at building models of system operation using the apparatus of algebra algorithms. The first step in the implementation of the algebra of algorithms is the description of uniterms and sequence synthesis [14], which is given below.

Formed uniterms: T_1 - uniterm of input and saving of token of input; $F(w)$ - unit term of employee search; $F(p)$ - uniterm for determining the location of the employee; S - unit term for determining statistics for the selected period; C - uniterm of payment accrual; $M(t)$ - unit of formation of the task board; $A(t)$ - unit of administration of tasks; $S(t)$ - unit assignment term; $M(q)$ - unit of formation of results of activity (results). As a result of use of the device of algebra of algorithms the following sequences are synthesized:

S_1 - sequence of system operation in case of selection of task management 1

$$S_1 = \overbrace{F(w)\,,\,F(p)}$$

S_2 - the sequence of operation of the system in the case of the choice of accounting for working time

$$S_2 = \overbrace{S\,,\,C}$$

S_3 - sequence of system operation in case of selection of task management 2

$$S_3 = \overbrace{M(t)\,,\,A(t)\,,\,S(t)}$$

The next stage is the synthesis of eliminations. It is listed below.

L_1 - elimination of the check on the choice of task management 1

$$L_1 = \overline{S_1 \quad ; \quad * \quad ; u_{\bar{1}}?}$$

where u_1 - uniterm conditions for selecting task management 1.

The elimination of L_2 with the condition of the choice of time accounting u_2 is responsible for the choice of time accounting:

$$L_2 = \overline{S_2 \quad ; \quad * \quad ; u_{\bar{2}}?}.$$

L_3 – elimination of the check on the choice of task management 2

$$L_3 = \overline{S_3 \quad ; \quad * \quad ; u_{\bar{3}}?},$$

where u_3 - uniterm conditions for selecting task management 1.

Elimination of L_4 with the condition of choice of time accounting u_4 is responsible for the choice of time accounting:

$$L_4 = \overline{M(q); \quad * \quad ; u_{\bar{4}}?}.$$

After substituting the sequences S_1, S_2, S_3 in the corresponding eliminations L_1, L_2, L_3 we obtain the following eliminations:

$$L_1 = \overline{\overparen{F(w) \; , \; F(p)} \quad ; \quad * \quad ; u_{\bar{1}}?},$$

$$L_2 = \overline{\overparen{S \; , \; C} \quad ; \quad * \quad ; u_{\bar{2}}?},$$

$$L_3 = \overline{\overparen{M(t) \; , \; A(t) \; , \; S(t)} \quad ; \quad * \quad ; u_{\bar{3}}?}.$$

The general structure of the formula of the algebra of algorithms of system functioning will have the following form (S_0):

$$S_0 = \overparen{T_1 \; , \; L_1 \; , \; L_2 \; , \; L_3 \; , \; L_4}$$

After substituting the corresponding eliminations and sequences in the formula S_0 we obtain the following formula of the algebra of algorithms of system operation:

$$S_0 = \left(\left(\left(\left(\overset{T_1}{\underset{,}{\vphantom{T}}} \, \overparen{F(w) \, , \, F(p)} \; ; \; * \; ; u_{\bar{1}} ? \right. \right. \right. \right.$$

$$\left. \overparen{S \, , \, C} \; ; \; * \; ; u_{\bar{2}} ? \right.$$

$$\left. \overparen{M(t) \, , \, A(t) \, , \, S(t)} \; ; \; * \; ; u_{\bar{3}} ? \right.$$

$$M(q) \; ; \; * \; ; u_{\bar{4}} ?$$

Using the rule of making the same uniterms for the sign of operations, we obtain the final formula of the algebra of algorithms:

$$S_0 = \left(\overset{T_1}{\underset{,}{\vphantom{T}}} \; \left(\left(\left(\left(\begin{matrix} M(t) \\ , \\ A(t) \\ , \\ S(t) \end{matrix} \; \overset{;}{} \; M(q) \; ; \; * \; ; u_{\bar{4}} ? \right) ; u_{\bar{3}} ? \right) ; \left(\begin{matrix} S \\ , \\ C \end{matrix} \; ; \overline{u_{\bar{2}}} ? \right) \right) ; \left(\begin{matrix} F(w) \\ , \\ F(p) \end{matrix} \; \overline{; u_{\bar{1}} ?} \right) \right) \right)$$

The next step was to design a system using an object-oriented approach [15]. Namely, at the beginning of the design a diagram of precedents is created, which is shown in Fig.4.
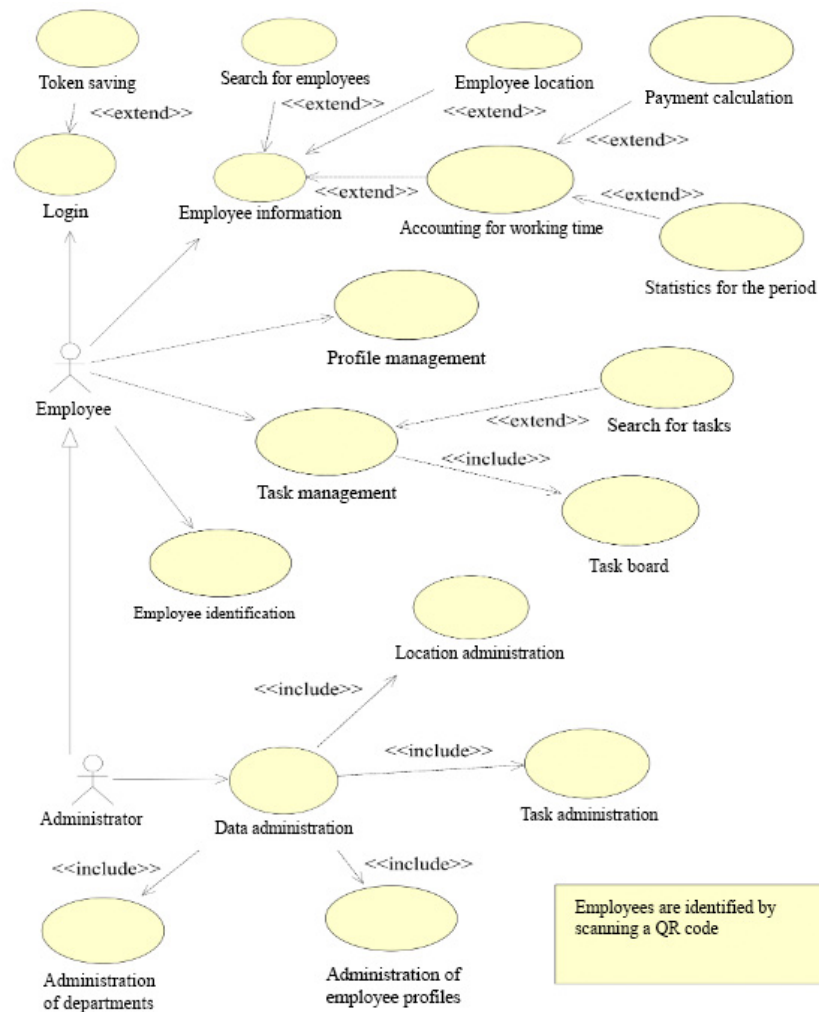
Figure 4: Diagram of usage options

The main external entities are: the employee (gets limited access to system resources, and contains functions for changing profile data, adding tasks / comments / applications, etc.) and the administrator (employer), who has full access to system resources. The main functions of the system are: data administration (includes administration of departments, employee profiles, tasks and locations; this function is available only to the system administrator), login (for security is implemented using a token system) [16], employee information (includes contact details and provides means of locating employees and accounting of working hours), profile management (provides for changing employee profile data), task management (displays information about the time of the task and contains many filters), employee identification code generated on the mobile device by the camera connected to the Raspberry Pi).

The class diagram of the designed system is presented in Fig. 5. This diagram shows the main classes of the model with their methods and attributes. According to the diagram of use cases (Fig.4), the following main classes were identified: Status, Authority, Department, User, Employee, Location, Priority, Comment, Ticket, Timecard, Attachment, Worksession, which represent the static structure of the system model and which was used to generate "code blanks using IBM Rational Rose software.
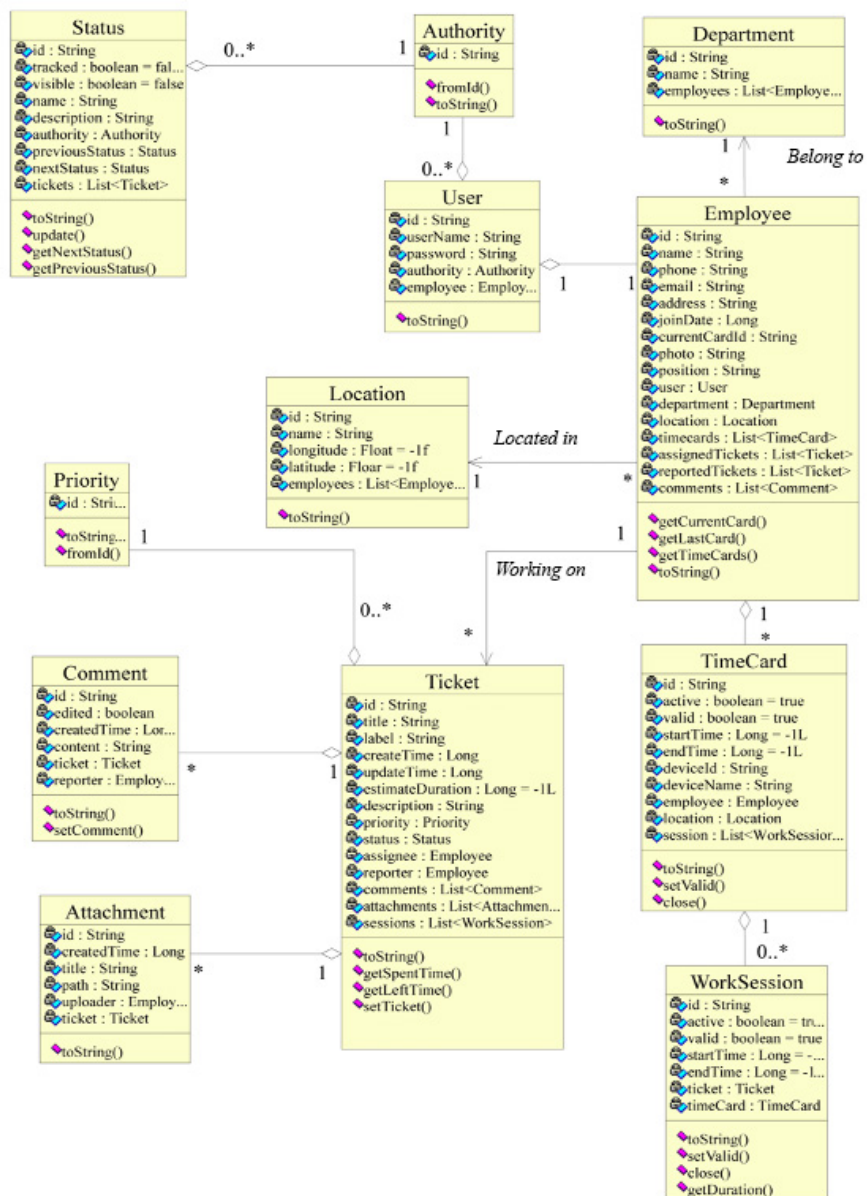
Figure 5: Class diagram

In order to describe the basic procedures and business processes, the activity diagram presented in Fig.6 was constructed. It reflects the dynamic aspects of system behavior and facilitates its construction using direct and inverse design methods.
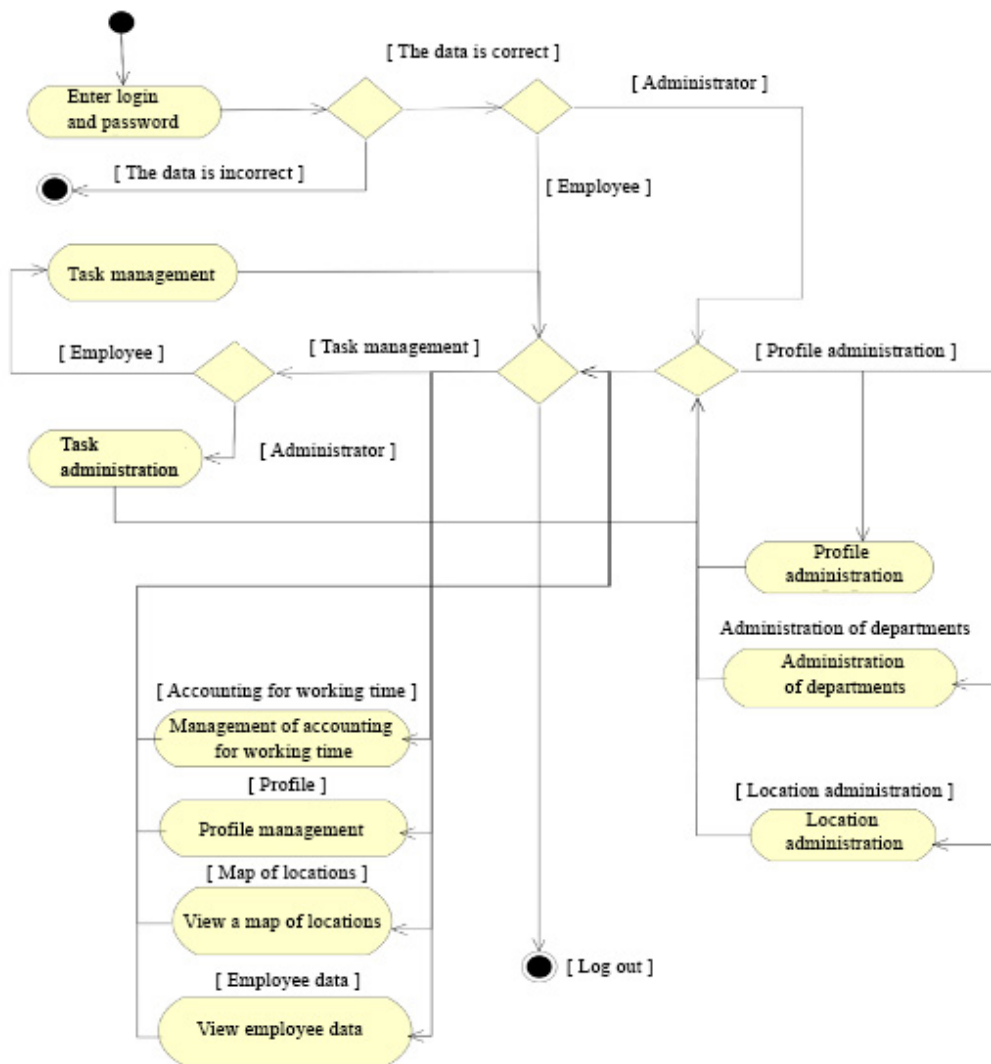
Figure 6: Activity chart

Based on the conducted system analysis, functional and non-functional requirements to the system were determined. Among the non-functional are:

- Cross-platform - will provide the means to use it regardless of the software and hardware platform;
- Ease of use associated with the rapid adaptation of potential users;
- Security - provides protection of data from unauthorized access;
- Data reliability - the system must verify the input data;
- Scalability - the ability to add new modules to increase functionality.

Functional requirements.

- Working time accounting - the system must provide automated accounting of working time of employees and generate detailed reports;
- Task management - the system must provide an automated process of task management and integrate it with the process of accounting for working time of staff;
- Quick access to current tasks - a mechanism for quick access to current tasks should be introduced in the information system;
- Calculation of benefits - the system must implement the process of calculating benefits to employees for a certain period;

- Employee location - access to employee location data within the workspace must be implemented in the information system.

After the market analysis, a decision was made to implement an information system in the form of a web application using the Angular.js framework. The use of this framework was determined by the following features [17]:

- Declarative user interface - contains many components, which greatly simplifies the development of web applications, and dynamic generation of HTML code.

- Implementing the Dependency Injection template provides opportunities for project testing when creating a Single Page Application.

- Two-way Data Binding helps automatically synchronize model data with data displayed to the user and implemented using the Raspberry Pi.

- Productivity is enhanced by data caching and other optimization mechanisms, in particular the framework reduces the load on the server by reducing requests to it.

The login window of the developed software is shown in Fig.7. Namely, when launching a web client, depending on whether the access cookie is stored in the browser's cookies, automatic authentication is performed. The windows are displayed with the support of the standard of human-machine interaction [18].
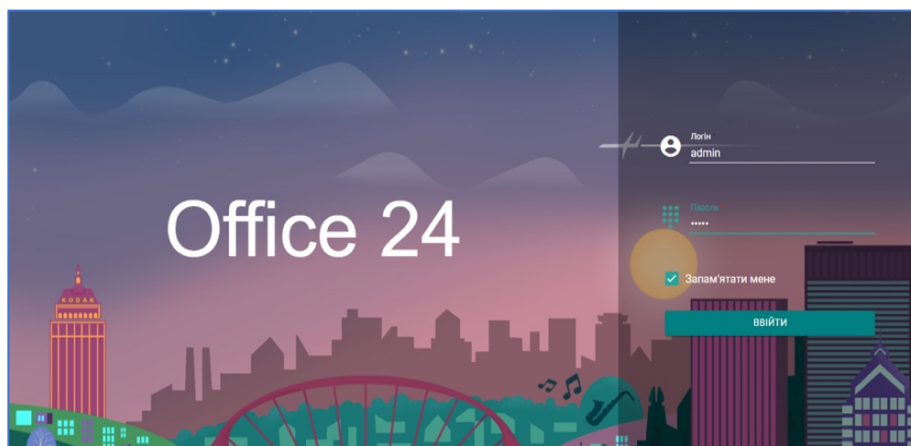

Figure 7: Login page

If the authentication is successful, depending on the user's access rights, it is redirected to either the admin panel (Fig. 8a) or the employee panel (Fig. 8b). In case of an error of automatic authentication or absence of a token, the user is redirected to the login window.
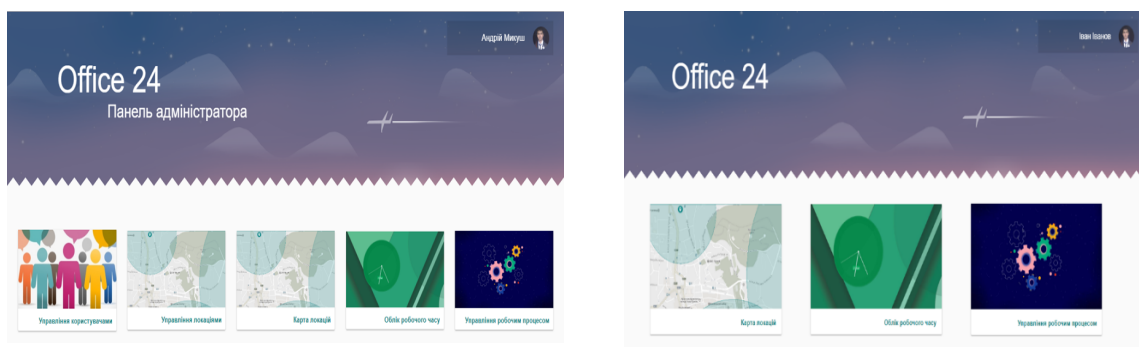

Figure 8: a) Administrator panel b) Employee panel

Employee panel. The employee panel provides access to the following functions: Profile management, Viewing personal data of staff, Access to staff location, Accounting for staff working hours, Task management. When viewing the location of staff, the user has the opportunity to view the presence of employees in the workplace (locations). You can select a location on the map by double-clicking on the location marker and in the left sidebar (Fig. 9).
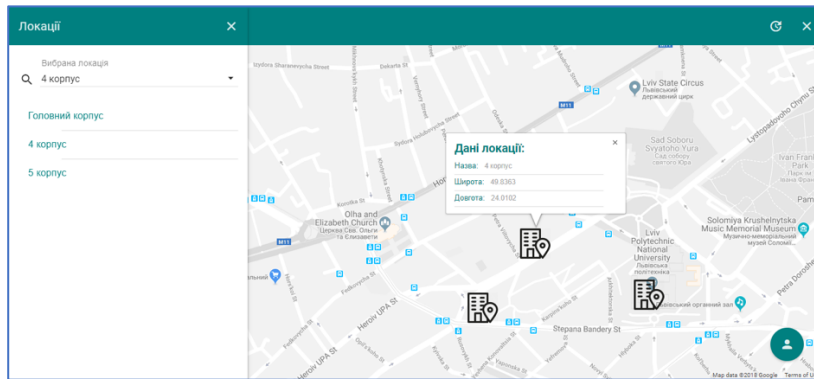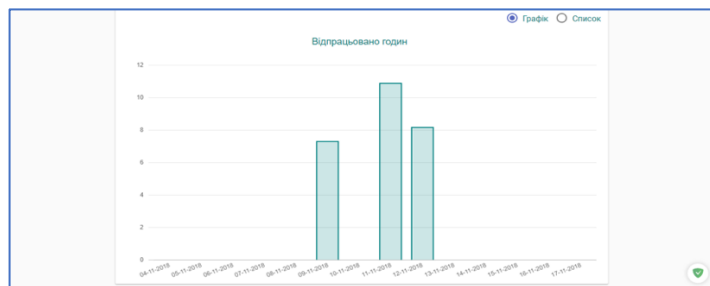
Figure 9: Location selection

The list of employees currently present in the selected locations is displayed in the right sidebar, which can be opened by clicking on the button in the lower right corner. You can also update this list by clicking the "Refresh" button on the toolbar. At the top of the page displays basic information about the accounting of working hours. There are two options for viewing time and attendance: schedule (bar chart presentation), list (contains a list of work sessions per day, showing: employee location, start and end of session, session duration, device from which the employee was identified) administrator only).
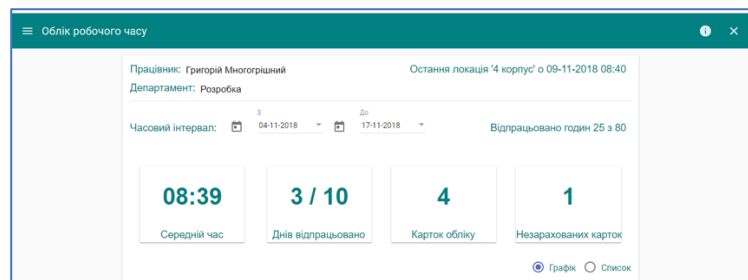
Figure 10: Accounting for working time (general information)

Figure 11: Accounting for working time (schedule)

Figure 12: Accounting for working time (list)

To navigate between pages related to task management, on the left is a toolbar that is common to all pages, which allows you to quickly switch between pages. Toolbar elements: exit the task management page, task board, recent tasks, new task, state administration (only available to the administrator).
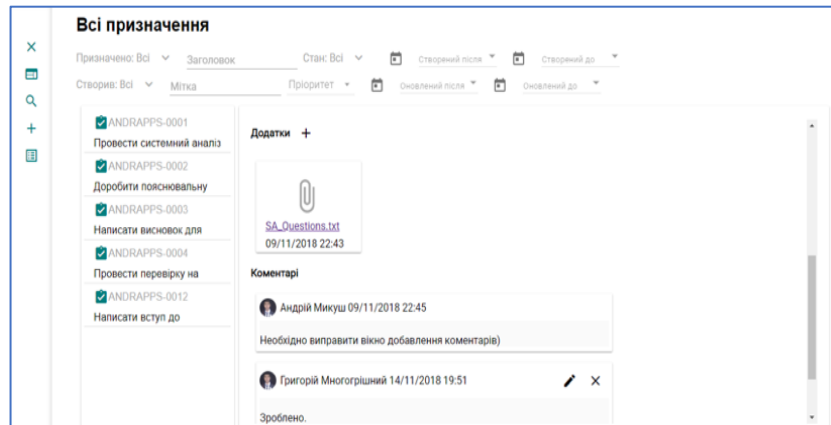

Figure 13: All tasks (appendices and comments to the task)

When entering task management, the system redirects the user to the task board (Fig. 14). The taskbar displays tasks grouped by states, which are marked as the most important. In this way, the user immediately has access to the most relevant tasks. On the task board the filter on the text, or on the worker on whom the task is assigned is also implemented. When you click on a task, a dialog appears with information about it, so the user can immediately view information about current tasks that interest him.
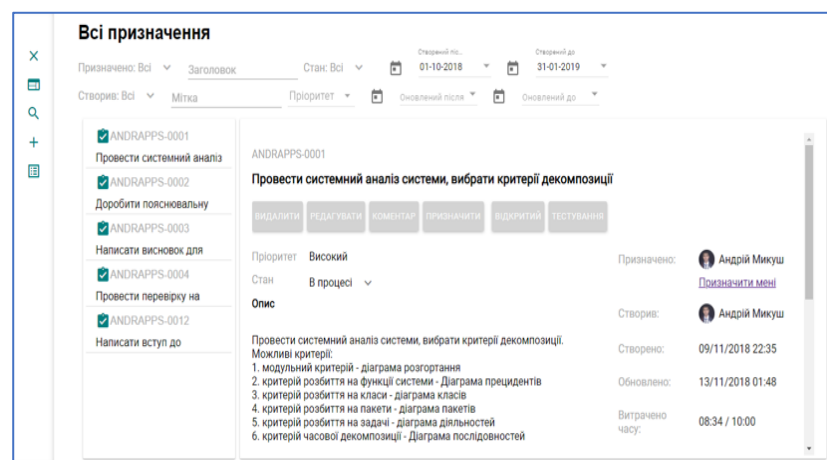

Figure 14: List of all tasks

On the All Tasks page, this page allows the user to view information about all tasks. For quick access to the task, there are many filters that can easily find the desired task. The selected task is displayed in the right pane of the page, the left pane displays all available tasks by filters. In the panel with the selected task, the user can not only view all the information about the task, but also add a comment, an appendix to the task. If the user created it, or has administrator rights, he can edit or delete the task. You can also change the status of the task (available states vary depending on user rights), or assign it to someone else.

6. Conclusion

As a result of the study, the existing technologies and tools for tracking employees' working hours were analyzed. As the analysis showed, today there are many software systems, but they are all

characterized by both commercial use and a certain violation of privacy requirements. Given that the study was a mathematical description of the subject area using the apparatus of algebra algorithms, which provided the necessary basis for the synthesis of mathematical and software system that would fully implement the functional component of the developed system of interactive tracking of employees.

Further work was focused on object-oriented design of the future software system by constructing multiple diagrams using the CASE system IBM rational Rose. Next, the system was designed using the Angular.js framework, followed by system verification.

Further research will be aimed at creating related software modules (payroll, biometric control), their verification and coordination of operation.

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