Management Project of Hospital Information System

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Abstract

The successful treatment of a patient admitted to a medical institution largely depends on the correct organization of the treatment process at all its stages. Starting from the initial examination and establishment of medical documentation to its discharge. The availability of a convenient information system also plays an important role, making it easier for the medical staff to record patients and reduce the time for keeping documentation. An information system was created that would provide employees of medical institutions with the opportunity to effectively manage patients' medical records: to record diagnoses, examinations, appointments, and procedures, and would also contain additional functionality, for example, information directories. During the execution of the work, modern world medical practices and standards are taken into account.

Keywords 1

Hospital information system, project management, automation of patient registration, medicine, electronic medicine

1. Introduction

In the modern world, every day people encounter a huge amount of information that is used for the functioning of various institutions and each time it becomes more and more, and manual processing of it becomes more and more difficult and less expedient, so information systems are becoming relevant here – a set of organizational and technical means for saving and processing information in order to meet the needs of the user.

The information system for the automation of patient registration in medical institutions, which must be designed as a result of the startup, is one of the simplest types of hospital information systems. So, let's consider the main functionality of the information system.

Hospital information system (HIS) is a complex software product, the main purpose of which is the automation of all the main processes related to the work of medical institutions of general and narrow specialization. Automated hospital information systems allow you to quickly and efficiently establish electronic document flow, flexibly structure work with patients, keep operational records of the work of administrative personnel, control all organizational and financial issues. [1]

The hospital information system includes various blocks that are responsible for optimizing certain aspects of the work of a medical institution.

HIS helps [2]:

- Improve the work of the registry office, and simplify the process of creating patients' medical records and the appointment procedure.
- Organize all administrative information.
- Unify medical documentation: patient charts, medical appointments, data on employees and medical services, schedules, analytics and statistics, and reports.
- Systematize all medical research data.
- Manage and allocate resources of the institution, including finance and accounting.

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- Analyze the activity of a medical institution. Receive various reports.
- Keep warehouse records of medical institutions. Check the state of the warehouse and receive data on stocks, deliveries and calculations, circulation of consumables.
- Monitor and adjust the work of diagnostic offices and laboratories.
- Automate the standards of providing medical care.

2. Analysis of similar software systems

MedElement

Hospital information system developed in Kazakhstan. A combination of cloud services and a powerful reference system for doctors, medical students and everyone who cares about health. The field of application of MedElement is the automation of the work of clinics, DRT clinics, dentistry, pharmacies, power supply units, private medical practices. An interesting feature of this HIS is that, in addition to supporting the main modules, it is a powerful help system. It contains directories of diseases, medical terms, laboratory indicators, medicines, reviews of world periodicals, etc. The Table 1 shows its main pros and cons. [3]

Doctor Eleks

A comprehensive solution that allows you to optimize the work of clinics of any size and profile (private and public). The developer is Eleks (Lviv, Ukraine). Doctor Eleks supports the patient's electronic medical record, tools for editing document templates, a personal doctor's office, a registry module and work with reporting, finances, personnel. The schedule subsystem allows you to create work schedules for employees, taking into account the wishes of doctors and patients. Doctor Eleks laboratory information system can be used as a separate software product. Additional features include a full-fledged editor for processing videos and images that can be added to documents. Doctor Eleks is connected to the eHealth system, the system has been tested and recommended for use by the Ministry of Health of Ukraine. The Table 1 shows its main pros and cons. [4]

Table 1

Advantages and disadvantages of our Project of HIS analogues

Name	Advantages	Disadvantages
MedElement	• automation of all medical documentation • generating reports • collection of marketing information • accounting of finances, services • convenient web services • the availability of a mobile application for quickly finding a doctor • appointments • conducting communication • clinical decision support technology • connection to the online database of interactive medical directories	• not very convenient interface • support too many functions
Doctor Eleks	• powerful functionality • availability of a communication server for data exchange in HL7 format with adjacent information systems • external laboratories, insurance companies • integration with Toshiba ultrasound is present • DICOM image import is supported • connection of DICOM-compatible equipment is supported	• e-directions are not supported • however, most are so minor that they are more than compensated for by other opportunities

Regarding other scientific papers:

Intelligent System "Family Doctor" by Andryi Helyia , Nataliia Kunanetsa , Antonii Rzheuskyib , Andrii Sihaiova and Parviz Kazymi

In recent years, there has been a notable shift in medical institutions towards electronic reporting, facilitated by software products that enhance the experiences of both patients and doctors. There is an ongoing need to further develop such information systems, particularly in the realm of telemedicine, where existing solutions remain insufficiently advanced. The Intelligent System "Family Doctor" aims to develop a cutting-edge mobile application for remote patient treatment, is both innovative and distinct from existing solutions. The mobile application will enable users to communicate with their family doctor or a specialist, and provide additional features such as medication reminders and appointment scheduling. [5]

Mobile Application for Preliminary Diagnosis of Diseases by Edgars Vasilevskis1, Iryna Dubyak, Taras Basyuk, Volodymyr Pasichnyk, Antonii Rzheuskyi

The information system for evaluating patient symptoms, generating an initial diagnosis, and offering recommendations for consulting a specific medical specialist has been undertaken. The current recommendation system encompasses several primary functions: establishing a preliminary medical diagnosis based on identified symptoms; creating reminders for medication intake; and maintaining a record of medication history. [6]

Information Technology Platform of "Smart" Dental Clinic by Nataliia Kunanets, Volodymyr Pasichnyk, Petro Kravets, Yaroslav Kis, Roksolana Havryliv and Antonii Rzheuskyi

The information system for process support in a "smart" dental clinic aims to enhance management efficiency and improve the quality of medical services. It offers high-tech support functions for patient records, patient admission schedules, electronic medical records, insurance company payments, reporting services, and the generation of both regulated and unregulated financial and statistical reports. The overall functionality of this information system is fundamental to a broad range of similar systems and is valuable and sought-after by both clients and dental professionals. [7]

Information Technology Platform "Dental laboratory" by Yaroslav Vyklyuk, Nataliia Kunanets, Tetyana Kalahurka and Mykhailo Voronovsky

The paper aims to analyze the functioning of the developed intelligent information system "Dental Laboratory" and the tools and methods used to implement its client-side components. A process-oriented approach was utilized for the development of the intelligent information system. The paper contains a series of diagrams that shape the concepts and ideas for the presentation of the intellectual information system "Dental Laboratory" were created. [8]

As a result, most of the systems proposed in publications relate to dentistry or process optimization. The system described in this work is designed to help employees and patients of medical institutions in various directions by optimizing the treatment process.

3. Presentation of the main results

3.1. Functional

The use case methodology, a widely recognized approach for modeling and analyzing software requirements, provides a systematic way of capturing system requirements and user interactions in a structured and comprehensive manner. In the realm of medical information systems, use cases facilitate the understanding of the intricate relationships between various system components and stakeholders. The Use Case diagram is used for understanding how users will perform tasks on the system . It outlines, from a user's point of view, a system's behavior as it responds to a request. Use cases provide a solid foundation for system design, allowing developers to understand the functional requirements and user interactions, leading to the development of a robust and efficient medical informational system.

A use case diagram (Figure 1) was created to visualize users' interactions with the system.

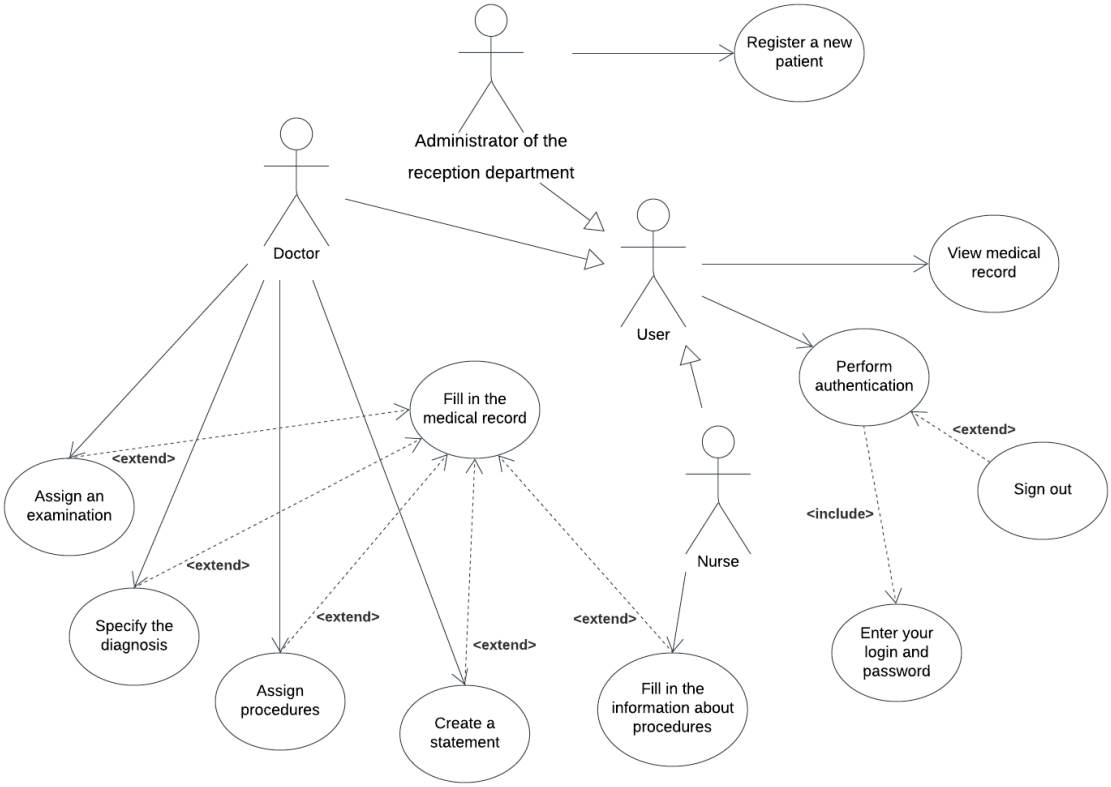

Figure 1: The view of the use case diagram for the designed systems

The table below (Table 2) describes the actors and usage options for each of them. It presents an overview of different user roles and their associated use cases within a hospital's patient information system. A brief description of the actors of the system may look the next way: the user is a hospital employee who accesses the patient information system for authentication and reviewing medical histories. The user can log in using their full name and password, log out of the system, and request the system to display a patient's treatment data. The administrator of the reception department is a hospital employee responsible for registering newly arrived patients in the system. The administrator should have an ability to enter the new patient's information. The doctor is a medical professional who diagnoses, prescribes examinations, procedures, and forms a discharge for patients. The doctor should have an ability to enter various data about the patient's treatment course, enter information about examinations, input the patient's diagnosis and information about the prescribed patient procedures, and form a discharge. The nurse is a hospital employee with secondary medical education who performs procedures as prescribed by a doctor and documents the procedures performed. The nurse can input various data.

The table below (Table 2) provides a clear and concise representation of the user roles and their corresponding use cases, facilitating a better understanding of the patient information system's functionality and user interactions.

Table 2

Description of displayed options using and actors using comments

Use case diagram element	Comment
Actors	
User	A hospital employee who uses the patient information system (authenticates, reviews medical history).

Administrator of the reception department	A hospital employee who registers newly arrived patients.
Doctor	A hospital employee with a full higher medical education who treats patients (prescribes examinations, indicates a diagnosis, prescribes procedures, forms a discharge).
Nurse	A hospital employee with a secondary medical education who performs procedures prescribed by a doctor and fills in information about the procedures performed.
Use cases	
Perform authentication	Log in with your name.
Enter your login and password	Enter the login – full name and password issued by the administration upon employment.
Sign out	Log out of the system.
Register a new patient	Enter data about the new patient in the appropriate fields.
Fill in the information about procedures	Enter data on the procedures performed by the patient in the appropriate fields.
Fill in the medical record	Enter data about the course of treatment.
View medical record	Make a request to the system in order to view data on the course of treatment.
Assign an examination	Enter into the system information about examinations assigned to the patient.
Specify the diagnosis	Enter the patient's diagnosis into the system.
Assign procedures	Enter information about the procedures prescribed for the patient into the system.
Create a statement	At the end of the treatment, the doctor forms a discharge based on the treatment.

3.2. Requirements

3.2.1. Functional requirements

Authorization: Users (physician, administrator) must be authorized and verified to use the software. Users are automatically registered in the central database, including using means of electronic identification.

The rights of users to create, view, edit (amend and add) information must be demarcated:

The doctor can view and edit the user-patient information (health status, consultation status, free hours. Can create, and add to the central database information about prescriptions, referrals, and other medical records, and view and submit requests for changes and additions to the documents and information entered by him in the central database. May submit requests and get access to the data about the patient contained in the central database for the purposes of health protection, establishing a medical diagnosis, providing treatment or providing medical services, functioning of electronic of the health care system, if such a medical worker is entrusted with the duties of ensuring the protection of personal data and is subject to the legislation on medical confidentiality in the event that the patient (his legal representative) gives consent to this or without such consent in cases provided for by law.

The administrator can view, edit and add information about the user-patient and user-doctor;

The user can create, enter, review, and exchange declarations about the choice of a doctor who provides primary medical care (hereinafter – declarations), prescriptions, referrals, medical records, other information, and documents through electronic cabinets in accordance with the user's access rights;

The software must automatically record operations (introduction, review, changes, and additions, etc.) with information and documents in the central database and events that occur in the software and relate to its security.

3.2.2. Non-functional requirements

Non-functional requirements cover various aspects of a system, including security, reliability, availability, performance, and other parameters that affect its operation and use. The Table 3 shows the main non-functional requirements for our project.

Table 3

Non-functional requirements

Requirement	Description
Availability	The architecture and infrastructure of the application are designed to deliver 99% of monthly uptime.
Performance	Maximum initial load time of the application should take up to 15 seconds. Up to 500 unique active user accounts, up to 200 concurrent users.
Hardware Compatibility	The application will be developed to work on the latest versions of the most popular desktop browsers: Chrome v65.0+, Firefox v59.0+, Safari v11.1+, Microsoft Edge v41.0+ and Internet Explorer v11 on the following operating systems: Windows 7+ and OSX (macOS) 10.10.x+.
Reliability	Daily backups will be scheduled and stored into the server platforms provided backup storage for the databases and required to be uploaded documents and files.
Compliance	The system should comply with the HL7, CDA, xDT.
Localization	The system should support Ukrainian and English. Ukrainian should be used as a default interface language. Display date and time in the following format: DD.MM.YYYY and HH:MM
Documentation	We need to create User guide and Training materials.
Security	Password format: minimum length is 8 characters. It must contain at least one special character. It must contain lowercase and uppercase letters. It must contain at least one digit. The System should automatically log all user actions. The System should automatically log users in and out. The System should block the user account after a few unsuccessful attempts to login. Only authorized users should have access to the module according to the assigned roles. Differentiate users' access permissions and functionalities according to the determined roles.

3.3. Development

3.3.1. Structure

A Gantt chart (Figure 2) outlines a project timeline, where different tasks are grouped by their corresponding phases such as "Requirements gathering," "Design," "Development," and "Testing." This chart contains information on each task's name, duration, start, and end dates, as well as its corresponding percentage completion and the number of days elapsed since the project started.

The project starts on January 2nd, 2024, and ends on December 31st, 2027, which is seen on the Gantt diagram. The longest phase in this project is the "Requirements gathering" phase, which takes 1022 days to complete, starting on January 2nd, 2024, and ending on December 31st, 2027. The "Development" phase has the most extended task, "Writing code," which takes 935 days and starts on June 3rd, 2024, and ends on December 31st, 2027.

The chart also shows that there are several milestones in the project, such as "Infrastructure preparation" (reaching 90% completion on May 30th, 2025), "Preparation for launch" (reaching 100% completion on September 30th, 2027), and "Product launch" (reaching 100% completion on December 31st, 2027). Moreover, the Gantt chart shows a few tasks in the "Testing" phase, including "Automatic testing," "Manual testing," and "User testing," each with their corresponding start and end dates, duration, and completion percentage. The “Testing” phase starts on October 1st, 2025, and ends on December 23d, 2027.

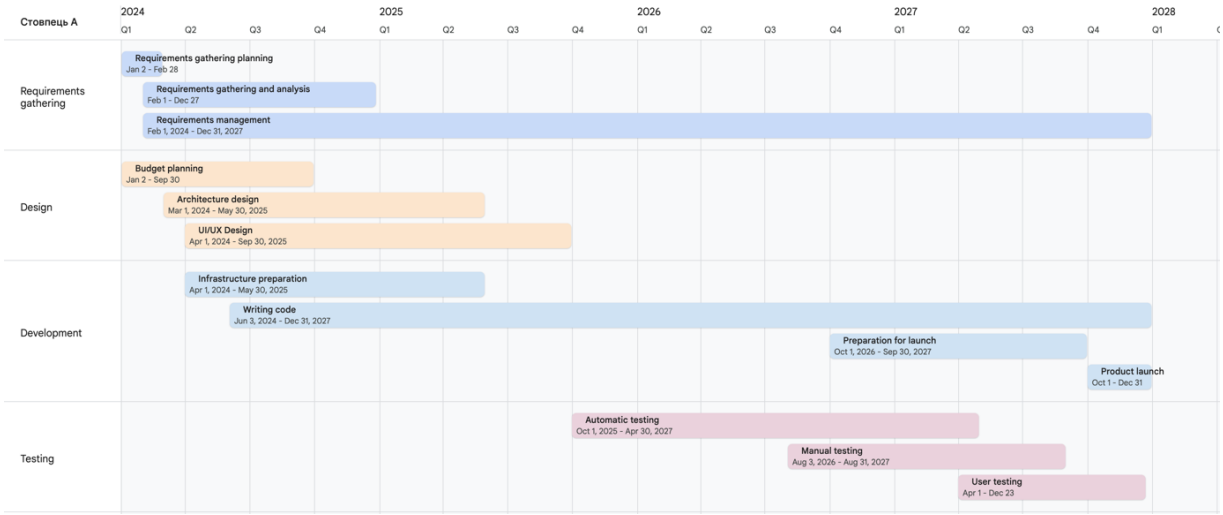

Figure 2: Gantt chart

For our project, we determined the list of works necessary for the creation of a software system and their distribution by stages of the life cycle, as well as the employees required to perform these works (Figure 3):

Project manager – deals with project planning, team management, and provision of resources.

Business analyst – analyzes business requirements, and determines user needs and software requirements.

UI/UX designer – develops the user interface design, and tests the interface.

DevOps – configures infrastructures, and automates development processes.

FrontEnd developer – develops the client part of the application, and tests the code.

BackEnd developer – develops the server part of the application, and tests the code.

System architect – develops system architecture, and defines technologies and tools.

Data Scientist – analyzes data, develops machine learning models, and tests models.

The Tester is responsible for testing the application and performing functional and integration tests.

The name of the task	Labor costs	Duration	Beginning	End
Collection of requirements	**11,275.2 h**	**1044 days**	**02.01.2024**	**31.12.2027**
Business analyst	*7,099.2 h*		*02.01.2024*	*31.12.2027*
Project manager	*4 176 h*		*02.01.2024*	*31.12.2027*
Hardware	*9*		*02.01.2024*	*31.12.2027*
Software			*02.01.2024*	*31.12.2027*
Requirements gathering planning	0 h	42 days	02.01.2024	28.02.2024
Requirements gathering and analysis	0 h	237 days	01.02.2024	27.12.2024
Requirements management	0 h	1022 days	01.02.2024	31.12.2027
Designing	**6,524 h**	**456 days**	**02.01.2024**	**30.09.2025**
Budget planning	780 h	195 days	02.01.2024	30.09.2024
Project manager	*780 h*		*02.01.2024*	*30.09.2024*
Architecture design	2,608 h	326 days	01.03.2024	30.05.2025
System architect	*2,608 h*		*01.03.2024*	*30.05.2025*
UI/UX Design	3 136 h	392 days	01.04.2024	30.09.2025
UI/UX designer	*3 136 h*		*01.04.2024*	*30.09.2025*
Development	**20,477.6 h**	**980 days**	**01.04.2024**	**31.12.2027**
Infrastructure preparation	3,294 h	305 days	01.04.2024	30.05.2025
DevOps	*2,074 h*		*01.04.2024*	*30.05.2025*
Data Scientist	*1,220 h*		*01.04.2024*	*30.05.2025*
Writing code	14,960 h	935 days	03.06.2024	31.12.2027
FrontEnd developer	*7,480 h*		*03.06.2024*	*31.12.2027*
BackEnd developer	*7,480 h*		*03.06.2024*	*31.12.2027*
Preparation for launch	1,774.8 h	261 days	01.10.2026	30.09.2027
DevOps	*1,774.8 h*		*01.10.2026*	*30.09.2027*
Product launch	448.8 h	66 days	01.10.2027	31.12.2027
DevOps	*448.8 h*		*01.10.2027*	*31.12.2027*
Testing	**3,957.6 h**	**582 days**	**01.10.2025**	**23.12.2027**
Tester	*3,957.6 h*		*01.10.2025*	*23.12.2027*
Automatic testing	0 h	413 days	01.10.2025	30.04.2027
Manual testing	0 h	282 days	03.08.2026	31.08.2027
User testing	0 h	191 days	01.04.2027	23.12.2027

Figure 3: Use of tasks

3.3.2. Costs overview

The main source of expenses for our project is salaries. In Figure 4 specified salary rates and one-time cost per unit of equipment, of which 9 units are planned in total. Next, a Cost Overview report was generated, showing the current cost status of the project and its top-level tasks, showing planned costs, residual costs, actual costs, cumulative costs, baseline costs, and percent complete as of a

specific date (in our case, January 1, 2025) to determine whether the project will be completed within the budget (Figure 4–6). Our total costs are UAH 5,121,440, and costs of UAH 4,103,552 remain.

Resource Name	Type	Initials	Std. Rate
Project manager	Work	PM	120,00 ₴/h
Business analyst	Work	BA	120,00 ₴/h
UI/UX designer	Work	UI	120,00 ₴/h
DevOps	Work	DO	120,00 ₴/h
FrontEnd developer	Work	FE	130,00 ₴/h
BackEnd developer	Work	BE	130,00 ₴/h
System architect	Work	SA	100,00 ₴/h
Data Scientist	Work	DS	100,00 ₴/h
The Tester	Work	QA	90,00 ₴/h
Hardware	Material	HW	11 000,00 ₴

Figure 4: Salary rates

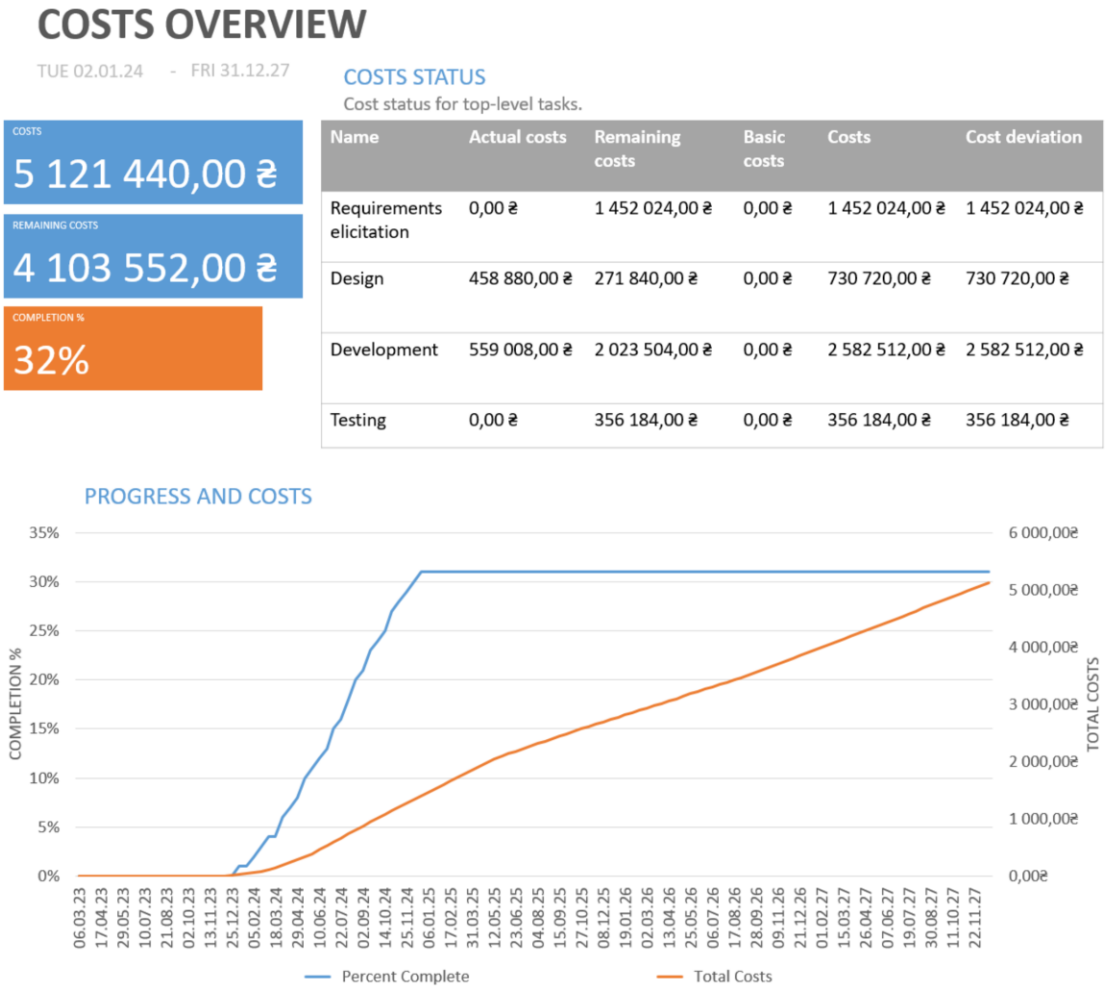

Figure 5: Cost overview part 1

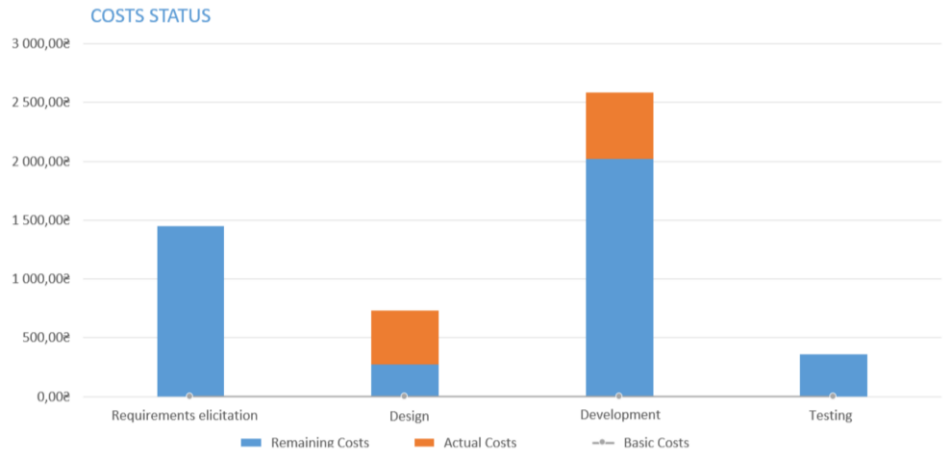

Figure 6: Cost overview part 2

4. Conclusions

Undoubtedly, for successful treatment, it is necessary to properly organize the treatment process. Today, the medical system in Ukraine is developing, including digitally, like other industries. However, the process of medical care is very responsible, and its optimization will only make life easier not only for patients, but also for medical personnel.

This project was developed taking into account the shortcomings that currently exist in some medical institutions of Ukraine. The planning of such a project is a very important stage, because at it, we first of all have to understand what resources to use and how to arrange the best development and implementation process.

In this work, we have developed a use case diagram for, first of all, medical personnel, in particular doctors and administration. Functional and non-functional requirements for the system were determined, which would help to understand what resources need to be used. This applies to personnel, budget and time. Thus, it is determined that the development of such an information system will take about 4 years and UAH 5,121,440. Of course, these values may change depending on the situation, for example, if there are requests for changes due to unaccounted risks, changes at the legislative level, etc.

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