

Nazar Plesh¹, Marian Hladun², Zhanna Parashchyn³, Vira Oksentyuk⁴, Aelita Krychkovska⁵

¹ Department of Computer Design Systems, Lviv Polytechnic National University, S. Bandery street 12, Lviv, Ukraine, E-mail: nazar.plesh.pp.2022@lpnu.ua, ORCID 0009-0003-9588-476X

² Information Protection Department, Lviv Polytechnic National University, S. Bandery street 12, Lviv, Ukraine, E-mail: marian.hladun.mkbas.2023@lpnu.ua, ORCID 0009-0007-9588-5892

³ Department of Computer Design Systems, Lviv Polytechnic National University, S. Bandery street 12, Lviv, Ukraine, E-mail: zhanna.d.parashchyn@lpnu.ua, ORCID 0000-0002-4922-2371

⁴ Department of Computer Design Systems, Lviv Polytechnic National University, S. Bandery street 12, Lviv, Ukraine, E-mail: vira.m.oksentyuk@lpnu.ua, ORCID 0009-0005-1491-6946

⁵ Department of Technology of Biologically Active Substances, Pharmacy and Biotechnology Lviv Polytechnic National University, S. Bandery street 12, Lviv, Ukraine, E-mail: aelita.m.krychkovska@lpnu.ua, ORCID 0009-0006-0783-7059

ARCHITECTURE DEVELOPMENT AND IMPLEMENTATION OF A MEDICINE SEARCH SITE USING THE DROGON FRAMEWORK

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Abstract. A new computer program (CP) has been created as a website for ATX classification groups to search for lists of medicinal products (MPs) as potential candidates for import substitution. The development of the CP with the conditional name "Computer Program for Import Substitution of Medicines" (CPISM) was carried out using open databases, which are regulated by the regulatory legal acts of the pharmaceutical industry of Ukraine. CPISM helps to quickly find lists of necessary medicinal products (MPs) subject to import substitution since these medicines are represented only by imported drugs in the Ukrainian pharmaceutical market. Using the CPISM website, you can obtain a list of pharmacological groups of MPs that require import substitution, which is especially important in martial law conditions. The production of these drugs can be implemented in domestic pharmaceutical enterprises. The advantages of the CPISM website, compared to other similar search programs, are the use and processing of 3 main drug databases with a convenient presentation: The State Register of Medicinal Products of Ukraine, the National List of Essential Medicinal Products, and the Register of Wholesale Prices of Manufacturers of Medicinal Products. This also allows searching for drugs by international non-proprietary names in all dosage forms with different dosages. CPISM is implemented as a web page and adapted for various devices. The architecture of the developed CPISM website is built based on a modular monolith. The web part and the data processing program are written in C++. The web part is implemented using the Drogon framework, providing an ORM for working with MySQL.

Keywords: website, medicines, architecture, database, Drogon framework,

Introduction

Ukraine has always been a powerful producer of completed medicines. There were over 200 industrial pharmaceutical enterprises on its territory. Today, domestic manufacturers of pharmaceuticals have GMP-certified production facilities, and the largest of them export their products abroad. However, the pharmaceutical market of Ukraine in 2022 underwent significant changes: a decline in production volumes, a loss of capacity in the occupied territories, and an increase in the cost of medicines. However, these negative aspects had a positive impact on the industrial segment of the pharmaceutical market, as they pushed the largest domestic manufacturers to search for new directions of development [1]. The topic of import substitution was discussed in Ukraine at various levels and for various industries long before the

beginning of difficult times associated, first, with the COVID-19 pandemic, and then with the full-scale Russian invasion. Import substitution of medicines is a type of economic strategy and economic policy of the state aimed at protecting domestic producers by replacing imported MPs with products of national production. In other words, the import substitution strategy involves a gradual transition to the country's self-sufficiency in domestic medicines and medical devices.

For the rapid search and identification of drugs that do not have established production in Ukraine, it is advisable to create a website [2,3] that would monitor MPs available in state registers and lists [4-6] that are not produced in Ukraine and constitute a segment of imported pharmaceutical products on the pharmaceutical market. In addition, such a site will help to quickly find the necessary MPs, as well as their analogs of both domestic and foreign production, which will make it possible to analyze and implement the opening of new production lines. It is also important that CP performs analysis based on various open databases according to various criteria, such as active pharmaceutical ingredients (API), pharmaceutical groups, and pharmaceutical companies. Accordingly, users could search for the necessary pharmaceutical companies and groups of drugs, MPs, that are registered in Ukraine. The resulting search result, based on the configured parameters, would indicate whether the selected MPs are included in the List [6], and also visualize the search by setting the appropriate check mark.

A wide range of different programming languages and frameworks or libraries are used to design, develop, and implement websites [3, 7]. Currently, there are many similar combinations: C# and ASP.NET, Python and Flask, Python and Django, PHP and Laravel, Java and Spring. Each technology provides tools for programming, debugging, testing, and deploying a software product. Implementing the program as a website will provide many advantages [8], including the ability to use all the functionality from any device and platform. This point is quite important, as it will allow more people to use our service. It will also simplify the development process, as there will be no need to maintain separate programs for various platforms. This work is devoted to the development of the architecture and implementation of the "frontend" and "backend" parts of the website "Computer Program for Import Substitution of Medicines" (CPISM) for searching for medicines and import substitution.

The Drogon framework was chosen to develop the CPISM website, which is used to create the "backend" part of the website and web servers for high-performance applications or products in the field of the Internet of Things. [9, 10].

Problem Statement

The goal of the work is to develop and implement a drug search site using the Drogon framework. Tasks to be solved in this work:

- Analysis and selection of software architecture for the CPISM website.
- Definition of the import-replace search algorithm.
- Implementation and implementation of a drug search site.

Review of Modern Information Sources on the Subject of the Paper.

Currently, there are many sites for searching for medicines by various criteria and groups. They are all implemented in different ways and have their own advantages and disadvantages [11, 12]. The most famous and used sites in Ukraine are Tabletki.ua [11] (fig. 1) та Apteki.ua [12] (fig. 2) - online services that provide information about the availability of medications and other pharmaceutical products in pharmacies with the possibility of booking; have a catalog of instructions for using medicines. The advantages of the sites include the large number of available medicines on the site and information about them. There is also the opportunity to get information not only about medicines, but also about hygiene, health and beauty products, as well as their prices.

Despite the advantages, site tabletki.ua has a number of disadvantages. Lack of detailed information about the medicine; usually, this information is limited to data from its instructions. Also, the search for analogs is implemented only by searching for the active substance and there is no search for analogs by the pharmacotherapeutic effect.

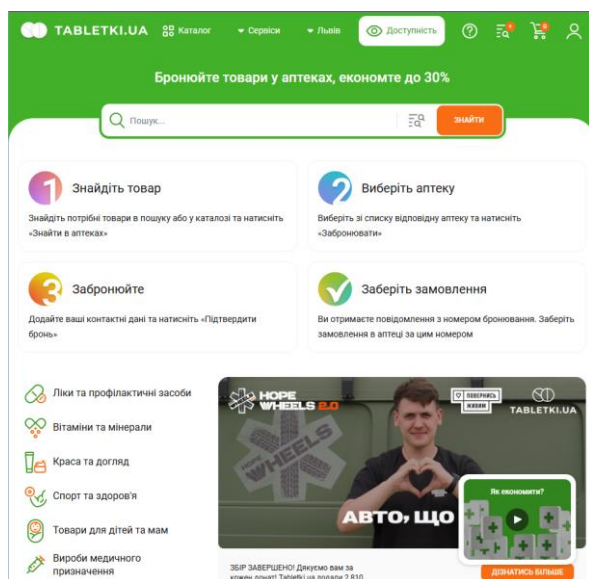


Fig. 1. Home page tabletki.ua.

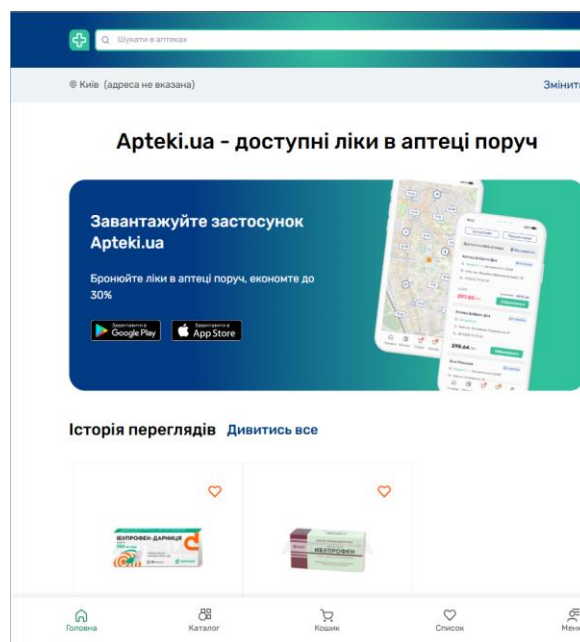


Fig. 2. Home page apteki.ua

Apteki.ua [12] is a repository of information about available medicines from the pharmacy network. The service helps you find all the necessary medicines at the best price, get an order at the nearest pharmacy. The advantages of the apteki.ua website are a wide range of products and medicines on the website, the availability of images of medicines and medical devices, and related products. It is also important to be able to view drug analogs, which can be useful. Despite this, the site has its drawbacks. The description of drugs is limited to instructions, which may be insufficient for the user, and the search for analogs is not available for all drugs. The list of similar drug search sites is much larger. This paper analyzes the most characteristic of them. As a result, the following can be summarized. Most of them have similar functionality, which is limited to searching for drugs, providing instructions for them, and the ability for consumers to book them at the pharmacy.

The development is interesting for potential customers - buyers, but it will be appreciated primarily by specialists in the pharmaceutical industry and management, since the state import substitution program has existed for a long time, but until now there was no tool that would help combine large databases of drugs with the isolation of the most necessary groups of drugs. In addition, this development will help in finding appropriate capacities for the creation of new pharmaceutical production facilities. Most existing sites are designed for simple search of MPs [11-13], and our proposed site, in addition to the specified algorithm, will analyze changes in the supply of medicines, offer a better choice and the possibility of implementing a technological process. This paper examines various popular platforms for creating websites, including the Drogen framework [10, 14] and the ASP.NET MVC framework. [15, 16]. Main advantages Drogen [10, 14]:

- is one of the fastest C++ web frameworks, thanks to the use of non-blocking I/O and efficient HTTP request processing.
- written in C++14/17/20, allowing you to take advantage of all the benefits of modern syntax and libraries [17, 18].
- Easily processing large numbers of concurrent connections thanks to support for asynchronous programming via `std::future` and `std::async`.
- Supports Linux, macOS, and Windows.
- Multifunctionality: built-in WebSocket support; HTML template generation; ORM (Object-Relational Mapping) for working with databases.
- Flexibility: Easily integrates with other libraries and is suitable for creating RESTful APIs, microservices, or web applications.

- Drogon is open source and has an active community on GitHub.

Disadvantages of using Drogon [9, 10, 14]:

- Difficulty in learning C++ compared to languages such as C# or Python.

- A smaller number out-of-the-box solutions: Compared to ASP.NET or other popular frameworks, Drogon has smaller number plugins, packages, and third-party integrations.

- The project is young: Drogon is not yet as popular as other frameworks, so the amount of documentation and training materials is limited.

- Smaller community: it may be harder to get help or find ready-made answers if problems arise.

Advantages ASP.NET MVC [13, 14]:

- Thanks to the MVC (Model-View-Controller) architecture, application logic, presentation, and data interaction are clearly separated. This improves code maintainability and scalability.

- ASP.NET MVC based on .NET Core provides high speed and efficiency, especially for server applications.

- A large number of libraries, plugins, and ready-made solutions that speed up development.

- Direct integration with databases (e.g. via Entity Framework), Azure, Active Directory, etc..

The disadvantages of ASP.NET MVC include: [15, 16]:

- For new developers or those who have previously worked with simpler frameworks (such as Laravel or Django), ASP.NET MVC may seem complicated due to the large number of concepts and configurations.

- Relatively poor performance in some cases. ASP.NET MVC is performant, but it is inferior to C++ frameworks.

- Strong attachment to the Microsoft ecosystem. Although ASP.NET MVC is cross-platform, taking full advantage of many features often involves integration with other Microsoft products, such as Azure or Windows Server.

- Applications can be large in size due to dependencies. This is not always optimal for microservices or resource-constrained environments.

Thus, taking into account all the advantages and disadvantages of Drogon and ASP.NET MVC, it is advisable to choose the Drogon framework for implementing the CPISM website.

Main Material Presentation

In general, the site architecture consists of the following main components: [2, 19]:

1. Frontend – the user side. This is the visual part of the site that the user interacts with, consisting of the site design, some interactivity, and data representations.

2. Backend – the server part that participates in processing data received from the user or through a request on the frontend side.

3. A database is an ordered set of data with a uniform structure.

The architecture of the developed CPISM website is built on the basis of a modular monolith [2, 20]. In general, the program is structured into small, independent modules that are responsible for separate functionality. All modules are combined into a single code base, which ensures ease of development and management. Compared to the usual monolith, this approach provides more opportunities for horizontal expansion.

Data sources. Various open MPs databases were used for the site. Among them is the list of basic medicinal products, the database of medicinal products registered in Ukraine, and the register of wholesale prices of medicinal manufacturers. During their processing, various errors and the absence of standards for filling out these lists were found. For this purpose, algorithms were developed that process all these inhomogeneities and record the already processed data into the database.

Implementation on Drogon. It is known that Drogon is a cross-platform framework that supports Linux, macOS, FreeBSD, OpenBSD, HaikuOS, and Windows. The main programming language in the Drogon framework is C++. Another important aspect of Drogon is the use of the model-view-controller (MVC) architecture pattern [2, 3]. This pattern greatly simplifies the development and modification of the program or its expansion, and also provides the ability to reuse individual program components. In

addition, in large systems, this pattern contributes to the orderliness of the code and the structure of the program. Taking into account the advantages and disadvantages of ASP.NET MVC and the implementation of the CPISM site, the Drogon framework was chosen (Fig. 3).

```

C:\Users\DELL>drogon_ctl help create
Use create command to create some source files of drogon webapp

Usage:drogon_ctl create <view|controller|filter|project|model> [-options] <object name>

drogon_ctl create view <csp file name> [-o <output path>] [-n <namespace>] [--path-to-namespace] //create HttpView source
files from csp files, namespace is prefixed of path-to-namespace

drogon_ctl create controller [-s] <[namespace:]class_name> //create HttpSimpleController source files
drogon_ctl create controller -h <[namespace:]class_name> //create HttpController source files
drogon_ctl create controller -w <[namespace:]class_name> //create WebSocketController source files
drogon_ctl create controller -r <[namespace:]class_name> [--resource=...]//create restful controller source files
drogon_ctl create filter <[namespace:]class_name> //create a filter named class_name
drogon_ctl create plugin <[namespace:]class_name> //create a plugin named class_name
drogon_ctl create project <project_name> //create a project named project_name
drogon_ctl create model <model_path> [--table=<table_name>] [-f]//create model classes in model_path
    
```

```

C:\Users\DELL>drogon_ctl help press
Use press command to do stress testing
Usage:drogon_ctl press <options> <url>
-n num    number of requests(default : 1)
-t num    number of threads(default : 1)
-c num    concurrent connections(default : 1)
-k        disable SSL certificate validation(default: enable)
-q        no progress indication(default: show)

example: drogon_ctl press -n 10000 -c 100 -t 4 -q http://localhost:8080/index.html
    
```

Fig. 3. Drogon_ctl toolkit.

Figure 3 shows: A – commands for creating file templates with class examples or full code files in case of creating models. B – the command and parameters for it are marked. The command is used for stress testing the site.

Import substitutions. An important component of the CPISM site is checking the status of import substitutions, which is implemented using algorithms for comparing data in the database with ATX codes. The functional diagram of checking the status of import substitutions is presented in Fig. 4

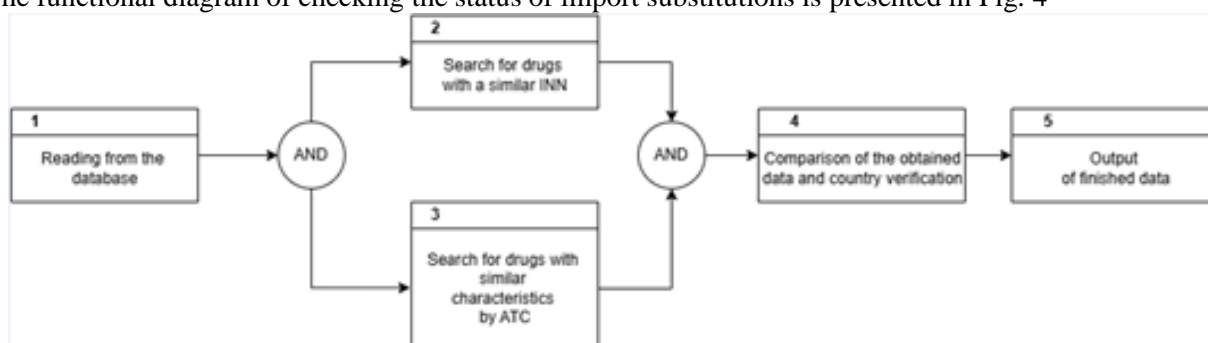


Fig 4. Functional diagram of import substitution search.

The implementation of this function on the site is shown in Fig. 5. The main algorithm involves searching and comparing the international non-proprietary name of medicine and ATX codes of medicine, thanks to which it is possible to understand the characteristics and pharmacological action of the medicine. The composition and form of release of medicine are also used in the analysis. When analyzing and comparing them, approximate correspondence algorithms are used.

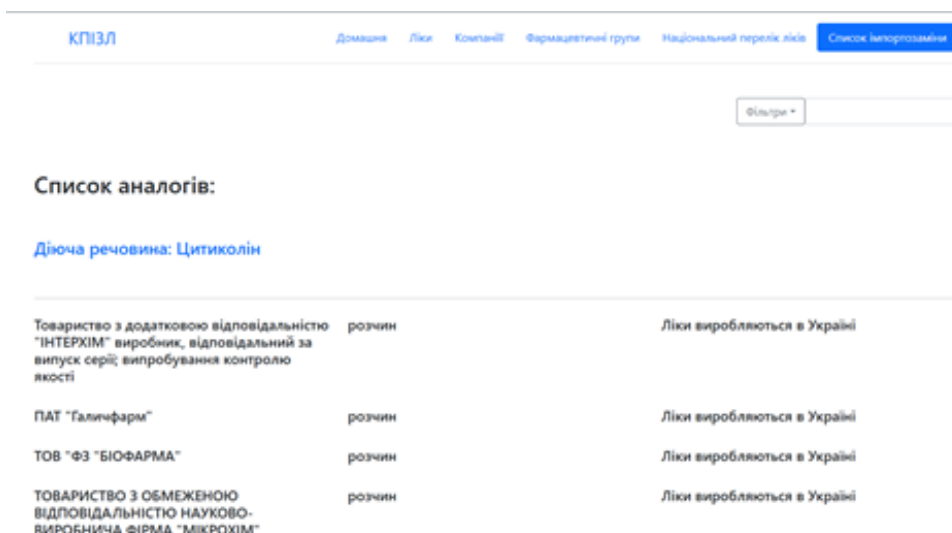


Fig. 5. Page view for searching for drug analogos.

Databases. The CPISM website contains a considerable number of tables that help the user to use the application easy and quickly (Fig. 6). All of them are located on the server. Databases are created using the MySQL database.

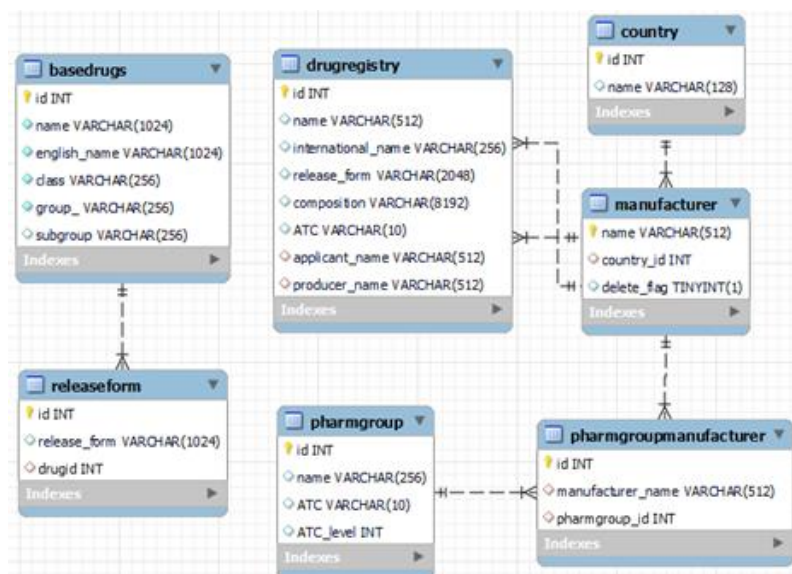


Fig. 6. Structure of the developed database.

When creating the database structure, all necessary data for further processing was taken into account, the main goal of which was to find import substitutions. The database schema was also normalized to simplify work with it and to avoid erroneous sampling results.

Results and Discussion

The developed CPISM website stands out from the existing ones in that it allows you to check the import substitution status of individual medicines, obtain the entire list of possible medicines that need to be introduced into domestic production, taking into account all the negative consequences of the difficult times in which we live.

The architecture of the CPISM site contains all the necessary components: user interface, server part, and database. The developed architecture and implemented site are built based on a modular monolith. This architecture allows you to quickly deploy the entire site. The server part of the site is implemented on the Drogon framework. The main advantages of using this framework are its speed and the C++

programming language, which contains all the necessary accompanying libraries for data processing, and a clear structure when developing the site, which is provided by the MVC pattern, according to which Drogon is implemented.

The disadvantages of the developed CPISM website include an insufficiently clear user interface, which can cause some difficulties during operation and the possibility of incorrect data on the status of import substitutions.

Conclusions

In this paper, a structure and implementation of a medicine search site based on the Drogon framework are implemented. The main advantages of using Drogon are as follows:

- High performance achieved through native compilation and memory control.
- Control over hardware resources: C++ allows developers to fine-tune the use of CPU, memory, threads, and other resources, which is important for building high-performance servers.
- Cross-platform: C++ allows you to create programs that are easily compiled for different operating systems (Linux, Windows, macOS).

The architecture of the CPISM site contains all the necessary components: user interface, server part, and database. The developed and implemented site architecture is built based on a modular monolith. All key elements of the site, such as medicine search, display of a list of medicines, manufacturers, import substitution, and data processing, are implemented through modular components within a single code base. A significant advantage of the developed server part is checking the status of import substitutions using search algorithms and comparing medicine according to various indicators and criteria.

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Назар Плеш¹, Мар'ян Гладун, Жанна Паращин³, Віра Оксентюк⁴, Аеліта Кричківська⁵

¹Кафедра систем автоматизованого проектування, Національний університет Львівська політехніка, вул. С. Бандери 12, Львів, Україна, E-mail: nazar.plesh.pp.2022@lpnu.ua, ORCID 0009-0003-9588-476X

²Кафедра захисту інформації, Національний університет Львівська політехніка, вул. С. Бандери 12, Львів, Україна, E-mail: marian.hladun.mkbas.2023@lpnu.ua, ORCID 0009-0007-9588-5892

³Кафедра систем автоматизованого проектування, Національний університет Львівська політехніка, вул. С. Бандери 12, Львів, Україна, E-mail: zhanna.d.parashchyn@lpnu.ua, ORCID 0000-0002-4922-2371

⁴Кафедра систем автоматизованого проектування, Національний університет Львівська політехніка, вул. С. Бандери 12, Львів, Україна, E-mail: vira.m.oksentyuk@lpnu.ua, ORCID 0009-0005-1491-6946

⁵Кафедра технології біологічно активних сполук, фармацевції та біотехнології, Національний університет Львівська політехніка, вул. С.Бандери 12, Львів, Україна, E-mail: aelita.m.krychkovska@lpnu.ua, ORCID 0009-0006-0783-7059

РОЗРОБКА АРХІТЕКТУРИ ТА ВПРОВАДЖЕННЯ САЙТУ ПОШУКУ ЛІКІВ ЗА ВИКОРИСТАННЯМ ФРЕЙМВОРКУ DROGON

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Анотація. Створено нову комп'ютерну програму (КП) як веб-сайт класифікаційних груп для пошуку списків лікарських засобів (ЛЗ) як потенційних кандидатів на імпортозаміщення. Розробка КП з умовною назвою «Комп'ютерна програма імпортозаміщення лікарських засобів» (CPISM) здійснювалася з використанням відкритих баз даних, які регламентуються нормативно-правовими актами фармацевтичної галузі України. CPISM допомагає швидко знаходити переліки необхідних лікарських засобів (ЛЗ), які підлягають імпортозаміщенню, оскільки на фармацевтичному ринку України ці препарати представлені виключно імпортними препаратами. На сайті CPISM можна отримати перелік фармакологічних груп ЛП, які потребують імпортозаміщення, що особливо важливо в умовах воєнного стану. Виробництво цих препаратів може бути реалізоване на вітчизняних фармацевтичних підприємствах. Перевагами сайту CPISM, порівняно з іншими аналогічними пошуковими програмами, є використання та обробка 3-х основних баз даних лікарських засобів із зручним оформленням: Державного реєстру лікарських засобів України, Національного переліку основних лікарських засобів та Реєстру лікарських засобів. Оптові ціни виробників лікарських засобів. Це також дозволяє здійснювати пошук препаратів за міжнародними непатентованими назвами у всіх лікарських формах з різними дозуваннями. CPISM реалізований у вигляді веб-сторінки та адаптований для різних пристроїв. Архітектура розробленого сайту CPISM побудована на основі модульного моноліту. Веб-частина та програма обробки даних написані мовою C++. Веб-частина реалізована за допомогою фреймворку Drogon, що забезпечує ORM для роботи з MySQL.

Ключові слова: вебсайт, медицина, архітектура, бази даних, фреймворк Drogon.