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FRAMEWORKS ANALYSIS AND EVALUATION USED IN THE WEB-APPLICATION DEVELOPMENT

This article presents the approaches used to analyze and evaluate modern frameworks that are used in the development of web applications. The analysis and evaluation of frameworks allow you to choose the framework that can be most efficaciously used for each specific case of software development. The popularity of using frameworks in the development of web applications is due to a significant reduction in the time and other resources spent on project execution. The article describes the concept of a framework as a technology for developing web applications and the classification of frameworks. Five main types of frameworks are briefly described. Criteria for the rationality of using frameworks for developing a web application are considered. The advantages and disadvantages of using them when creating web-oriented software are given. When evaluating web applications according to COCOMO model, software options were considered with the use of frameworks in development, and without the use of frameworks. This article provides an overview of the families of modern Back-End frameworks. A comparison of the functionality of the Back-End frameworks of six manufacturers for commercial software solutions is carried out. The choice of criteria for assessing the quality of frameworks is examined. As a basis, when choosing quality criteria, it is proposed to use the ISO 25010 standard. The coefficients of importance for the evaluation criteria, the values of which were obtained with the help of experts, are given. When forming the final assessment of the frameworks, such characteristics as functional suitability, security of working with data, modifiability, interface quality, interaction with payment systems, and integration with JIRA, compatibility, productivity were mentioned. General quality scores were obtained for all the frameworks under consideration. Assessing the quality of frameworks allows you to improve the process of developing a web-oriented software product, the purpose of which is to obtain a web application of a given quality.

Keywords: software, framework, Back-End, web applications, quality assessment, assessment criteria.

Ю. Р. СЕЛІВЬОРСТОВА, І. В. ЛЮТЕНКО, С. В. ОРЄХОВ

АНАЛІЗ ТА ОЦІНКА ФРЕЙМВОРКІВ, ЩО ВИКОРИСТОВУЮТЬСЯ ДЛЯ РОЗРОБКИ WEB-ДОДАТКІВ

У даній статті представлені підходи, які використовуються для аналізу та оцінки сучасних фреймворків, які використовуються при розробці web-додатків. Аналіз і оцінка фреймворків дозволяє обрати фреймворк, який найбільш ефективно може бути використаний для кожного конкретного випадку розробки програмного забезпечення. Популярність використання фреймворків при розробці веб-додатків обумовлена істотним зменшенням витрат тимчасових і інших ресурсів на виконання проекту. У статті наведено поняття фреймворку, як технології розробки веб-додатків і класифікація фреймворків. Коротко охарактеризовані п'ять основних типів фреймворків. Розглядаються критерії раціональності використання фреймворків для розробки веб-додатки. Наводяться переваги і недоліки використання їх при створенні веб-

орієнтованого програмного забезпечення. При оцінці веб-додатків по моделі COCOMO розглянуті варіанти програмного забезпечення з використанням фреймворків в розробці, і без використання фреймворків. У статті наведено огляд сімейств сучасних Back-End фреймворків. Проведено порівняння функціональності Back-End фреймворків шести виробників для комерційних програмних рішень. Розглянуто вибір критеріїв для оцінки якості фреймворків. В якості основи, при виборі критеріїв якості, запропоновано використовувати стандарт ISO 25010. Наведено коефіцієнти важливості для критеріїв оцінки, значення яких отримані за допомогою експертів. При формування підсумкової оцінки фреймворків розглядалися такі характеристики як функціональна придатність, безпека роботи з даними, можливість модифікування, якість інтерфейсу, інтеграція з платіжними системами і інтеграція з JIRA, сумісність, продуктивність. Отримано загальні оцінки якості для всіх розглянутих фреймворків. Проведення оцінки якості фреймворків дозволяє поліпшити процес розробки веб-орієнтованого програмного продукту, метою якого є отримання веб-додатку заданої якості.

Ключові слова: програмне забезпечення, фреймворк, Back-End, web-додатки, оцінка якості, критерії якості.

Ю. Р. СЕЛИВЁРСТОВА, И. В. ЛЮТЕНКО, С. В. ОРЕХОВ

АНАЛИЗ И ОЦЕНКА ФРЕЙМВОРКОВ, ИСПОЛЬЗУЕМЫХ ПРИ РАЗРАБОТКЕ WEB-ПРИЛОЖЕНИЙ

В данной статье представлены подходы, используемые для анализа и оценки современных фреймворков, которые используются при разработке web-приложений. Анализ и оценка фреймворков позволяет выбрать фреймворк, который наиболее эффективно может быть использован для каждого конкретного случая разработки программного обеспечения. Популярность использования фреймворков при разработке веб-приложений обусловлена существенным уменьшением затрат временных и других ресурсов на выполнения проекта. В статье приведены понятие фреймворка, как технологии разработки веб-приложений и классификация фреймворков. Кратко охарактеризованы 5 основных типов фреймворков. Рассматриваются критерии рациональности использования фреймворков для разработки веб-приложения. Приводятся преимущества и недостатки использования их при создании веб-ориентированного программного обеспечения. При оценке веб-приложений по модели COCOMO рассмотрены варианты программного обеспечения с использованием фреймворков в разработке, и без использования фреймворков. В статье приведен обзор семейств современных Back-End фреймворков. Проведено сравнение функциональности Back-End фреймворков 6 производителей для коммерческих программных решений. Рассмотрен выбор критериев для оценки качества фреймворков. В качестве основы, при выборе критериев качества, предложно использовать стандарт ISO 25010. Приведены коэффициенты важности для критериев оценки, значения которых получены с помощью экспертов. При формирования итоговой оценки фреймворков рассматривались такие характеристики как функциональная пригодность, безопасность работы с данными, модифицируемость, качество интерфейса, интеграция с платежными системами и интеграция с JIRA, совместимость, продуктивность. Получены общие оценки качества для всех рассматриваемых фреймворков. Проведение оценки качества фреймворков позволяет улучшить процесс разработки веб-ориентированного программного продукта, целью которого является получение веб-приложения заданного качества.

Ключевые слова: программное обеспечение, фреймворк, Back-End, web-приложения, оценка качества, критерии оценки.

Introduction. The massive appearance of sites has provoked the development of high-quality web-applications. The popularity of developing web resources for disseminating information has prompted the world to create new systems and programs that greatly facilitate the writing and development of web applications. These programs provide an opportunity to easily and simply increase the efficiency and speed of development at a lower cost, and the developer can focus on improving the understanding of the business logic of the program. A variety of programming languages, databases, and frameworks based on them contribute to the development and integration of various components.

Nowadays, frameworks have become very popular and are the most important part of web application development, they offer and define the structure of software. Using frameworks saves a lot of time by increasing the number of components for developers written for them, limiting the load of development processes, reducing project costs, using code duplication issues, and helping to build programs quickly. Developing a web application without the use of a framework becomes a difficult task to create, maintain, and upgrade all stages of the software life cycle. Also, the use of frameworks makes the process of creating programs more accessible and functional.

There are a large number of frameworks for developing web applications. Choosing the right framework for work is a difficult task because each of them has a large number of attractive features that the other does not have. To select a framework, you must first consider all existing solutions and choose the most appropriate for the task.

The purpose of this article is to present an approach to the analysis and evaluation of frameworks for web application development, which will improve the quality of software development. By choosing the right and based on the functionality framework, you can significantly reduce development time and create software, which corresponds to modern quality assessments.

Framework as a technology for developing web applications. “Framework” is a “construction” or “structure” [1]. It is a kind of special-purpose software environment that is used to significantly facilitate the process of combining certain components when creating programs. The framework allows you to add components as needed. It is the basis on which you can create a program for any purpose quickly and easily.

We can highlight a significant advantage of frameworks if we compare a framework and a dynamic library (DLL) with limited functionality. It is the link that unites all the software components used. Also, within the framework, there are often the necessary thematic libraries that are needed to develop a specific software system [1].

Classification of frameworks:

- application frameworks – use the paradigm of object-oriented programming, automate the process of creating graphical interfaces;
- software system frameworks – frameworks of a system or subsystem that have everything to facilitate the development and grouping of various components; include frameworks for the web;
- conceptual model frameworks – it is a theoretical concept of the given structure for decision-making methods of some problems or difficulties.

All of these frameworks make it easier to create an interface, connect to a database, and reduce the likelihood of duplicate code. Also, most modern frameworks are built on the MVC (Model View Controller) architecture, which proposes to divide the future system into independent parts so that changing one of the elements has minimal impact on other components [1].

The types of web-frameworks are shown in the following fig. 1. Knowing the types of frameworks makes it easier to choose a tool for developing a web application.

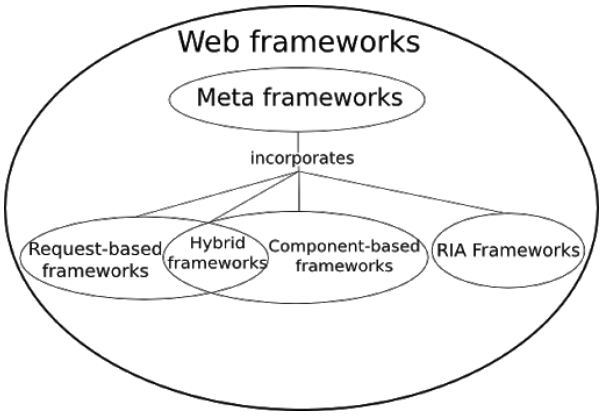

Fig. 1. Types of web-frameworks

Consider the types of frameworks in more detail [2]:

Request-based. Used to process requests from the user, but the data is stored only through sessions. Examples: Django, Ruby on Rails, Struts, Grails.

Component-based. Serve to abstract the processing of requests from the user inside the components and independently monitor the status, reminiscent of conventional graphical tools. Examples: JSF, Tapestry, Wicket.

Hybrid-based. It is combining request-based and component-based frameworks. They take control of all data and logical flow in the model generated in response to a request from the user of the system. The main advantage of such frameworks is that hybrid frameworks provide an object model of components that behaves differently in different situations. Besides, components can be separated and effectively added to other projects. Example: RIFE.

Meta-based. They have interfaces for general product maintenance and an easily extensible basis for adding new components and services. Example: Keel.

RIA-based. Exist to develop Rich Internet Applications (RIA), help develop applications that run in the browser. Examples: Flex, SAP Hybris.

Request-based and component-based are the most popular web frameworks.

Criteria to the rational use of frameworks for web application development. To better understand the need for frameworks in the development of web applications, you should focus on the criteria for the rational use of frameworks, which are given in table 1 [3].

Frameworks simplify the development of scalable and unique web applications. Although development using ready-made CMS is uncomplicated, unlike buildout with frameworks, but CMS is not designed for this. It should be noted that all unique web-applications developed with the help of the framework are developing dynamically. When a developer changes the system, for example, with a novelty in design, a new article, or section, it is enough to add only a new module.

Table 1 – Criteria for the functionality of using the framework

Name	Characteristic
Database support	Database support is an influential point because some frameworks support ORM and some do not, so depending on this criterion, you should choose the right framework for development.
Community support	The framework has to support the possibility of the simultaneous work of several developers.
Documentation	Some frameworks do not have documentation, or it is, but not relevant, so when choosing a framework, you should take into account the availability of appropriate, all the time updated documentation.
Productivity	The framework has to be productive in any system. Currently, a large number of frameworks are not efficient.
Threshold of familiarization	It is a crucial factor because it can happen that a year is not enough to become the master in the selected framework, and you have to develop a web application as soon as possible.
Development speed	Different frameworks require different time to develop an application.
Architecture	Give your preference to those frameworks that were designed using the MVC architectural pattern. It will help you in application development.
Using templates when developing UI	Using templates for the user interface significantly reduces resource costs.

Thus, the following are the advantages of using frameworks in the development of web-applications:

- software's flexibility and extensibility by adding additional libraries to the source code;
- the use of the MVC architectural approach, which extends the flexibility of the project and allows the output to receive clean code to facilitate further support;
- the existence of detailed documentation on the intricacies of development using the selected framework;
- security of use for prevention of hacking of the system;
- all the code is essential in the system, unlike a CMS (CMS creates countless code that is not used, and it reduces the efficiency of the project);
- an excellent output.

The disadvantages of using frameworks in the development of web-applications are somewhat insignificant compared to the advantages:

- the cost of development is cheaper than creating using a CMS because the time spent on development is several times less;
- difficulty in mastering;
- difficulty in maintenance;

- the requirement to develop unique additional modules and components that are put forward by the client.

Thus, comparing the existing advantages and disadvantages of using frameworks, we can conclude that the development of web-applications using frameworks is the best solution.

Evaluation of software with and without using framework by COCOMO model. In addition to the criteria for the rational use of frameworks, the software can also be evaluated by the COCOMO model by the number of lines in the developed web-application.

A web application developed using the framework is 40 KLOC in size and 63 KLOC without the framework. We calculate the costs and the time required for development according to COCOMO model [4]. For this purpose, we will use formulas 1-2, and we will take the data for them from table 2.

$$E = a_b * (KLOC)^{b_b} \quad (1)$$

where E – an effort in person-months;

$KLOC$ – the number of lines of the code in thousands;

a_b and b_b – data from table 2.

$$D = c_b * E^{d_b} \quad (2)$$

where D – amount of time required for the completion of the job in months;

$KLOC$ – the number of lines of the code in thousands;

c_b and d_b – data from table 2.

Thus, a web application developed using a framework belongs to an organic type of software, and without a framework to a semi-detached.

Table 2 – Constant values for COCOMO model

Software projects	a_b	b_b	c_b	d_b
Organic (2-50 KLOC)	2.40	1.05	2.50	0.38
Semi-detached (51-300 KLOC)	3.00	1.12	2.50	0.35
Embedded (>300 KLOC)	3.60	1.20	2.50	0.32

Thus, we have the following estimates of the efforts and duration of development using the framework:

$$E = a_b * (KLOC)^{b_b} = 2.4 * 40^{1.05} = 115.44$$

$$D = c_b * E^{d_b} = 2.5 * 115.44^{0.38} = 15.19$$

Therefore, using the framework, the development of a web application requires 115.44 person-months and 15.19 months. Let's calculate the cost of creating without using the framework:

$$E = a_b * (KLOC)^{b_b} = 3 * 63^{1.12} = 310.73$$

$$D = c_b * E^{d_b} = 2.5 * 310.73^{0.35} = 18.63$$

Based on the calculations made, without the use of the framework for the development of web-application requires 310.73 person-months and 18.63 months, which is much more than creating using the framework. Therefore, we can conclude that developing a web-application with the framework significantly accelerates it because the development time is reduced by almost 4 months.

An overview of modern Back-End frameworks. For Back-End, there are hundreds of frameworks implemented in different programming languages, such as Java, JavaScript, PHP, C#. Here are some of them for developing web applications using these languages.

SAP Hybris. It is a family of products of the German company Hybris, which sells software for e-commerce, marketing, sales, service, and product content management. SAP Hybris provides solutions that help any organization reduce costs, save time, simplify development, and require less attention to achieve excellent customer service [5]. The Hybris product focuses on the following main areas:

- commerce;
- marketing;
- billing;
- sales;
- service;
- Hybris as a service.

IBM. IBM's cloud platform combines Platform as a service (PaaS) with Infrastructure as a service (IaaS) to provide an integrated experience. The platform scales and supports both small development and organization teams and large business enterprises [6]. An integral part of it is source technologies such as Kubernetes, Red Hat OpenShift, and a full range of computing options. Thereby, the project has as much control and flexibility as the customer needs to support workloads in a hybrid environment. The developer can deploy applications that run in the cloud while ensuring the mobility of the workload.

ATG. Oracle ATG Web Commerce programs implement a component development model based on JavaBeans and JSP. The developers assemble programs from components by linking them between configuration files in Nucleus, Oracle's open object structure ATG Web Commerce. Page designers build an interface for a JSP application that uses the Oracle ATG Web Commerce DSP tag library. The DSP tag library allows you to embed Nucleus components in the JSP and use these components to supply dynamic content. This structural solution provides easy interaction between the programmer and the layout designer [7].

Demandware. Provides a cloud-based single e-commerce platform with mobile devices, Artificial Intelligence personalization, order management capabilities, and related services for Business to Consumer (B2C) and Business to Business (B2B) retailers and brand manufacturers worldwide [8].

Magento. An e-commerce platform was built on open-source technology that provides online retailers with a flexible shopping system, as well as control over the appearance, content, and functionality of their online store [9].

Heiler. Specializes in SAP customers and supports the purchase of companies in SRM and suppliers with the extraction, conversion, and publication of their product information, providing comprehensive solutions consisting of the latest software technologies [8]. Heiler provides distributors and manufacturers with product information

management support that allows them to optimize the information process with their customers.

Comparison of Back-End framework functionality. Each of these frameworks is a fitting solution and attracts with its advantages. Unfortunately, you have to make a choice based on the project to be developed because none of the frameworks can solve all the problems for any project. A comparison of the main functionalities of the above frameworks was shown in table 3.

Compared to IBM, Oracle, and others, the SAP Hybris web application development platform is ahead of its nearest competitors in many respects [10]:

- thoughtful architecture, which was created on the latest stack of Java-technologies;
- universal functionality in its class;
- accelerators for B2C and B2B commerce significantly accelerate the project;
- depending on the customer's needs, different software installation, and payment methods.

Criteria for assessing the quality of frameworks. The above frameworks for web application development have plenty of functionality. To more accurately select the framework for application development, it is necessary to choose quality criteria and their impact on the efficiency of development and implementation of the requirements. It was proposed to use the ISO 25010 standard as a basis for the selection of quality criteria. According to ISO 25010, quality software must meet the following norms [11]:

- functional suitability (completeness, correctness, expediency);
- efficiency (temporary behavior, use of resources, bandwidth);
- compatibility (coexistence, compatibility);
- usability (compliance of functions to needs, ability to learn, working capacity, protection against user errors, aesthetics of the user interface, accessibility);
- reliability (maturity, availability, failure stability, reproducibility);
- security (confidentiality, integrity, indisputability, responsibility, authenticity);
- maintainability (modularity, reusability, analysis, modification, testing);
- portability (manufacturability, the possibility of installation, and replacement).

The criteria described in ISO 25010 are used to assess the quality of the software. In our case, we will evaluate the previously selected frameworks as standalone software.

Fuzzy sets and fuzzy logic can improve the situation, as not, all ISO 25010 criteria need to be calculated, and help to use these criteria more accurately.

To assess the quality of frameworks, fuzzy logic can be used as a coefficient to assess the quality criterion. The higher the coefficient, the more significant the criterion.

The fuzzy set algorithm presented by A. Zade in 1965 was used to calculate the quality [12]. For the mathematical definition, X is used, which is a point in space (object), with a common element, denoted by x. Thus, $X = \{x\}$. The fuzzy set (class) A in X is characterized by the membership function (characteristic) $f_A(x)$, which associates with each point 2 in X a real number in the interval $[0, 1]$ with the value of $f_A(x)$, where x represents the "degree membership" x in A. Thus, the closer the value of $f_A(x)$ to one, the higher the degree of membership x in A. When A is a set in the usual sense of the word, its membership function can take only two values 0 and 1. Therefore $f_A(x) = 1$ or 0, according to x does not correspond to or does not belong to A. Accordingly, in this case, $f_A(x)$ is reduced to an informed characteristic function of the set A.

Verbal assessments and their corresponding coefficients are highlighted in the table 4.

Table 4 – The metrics of criteria's importance

Verbal assessments	Coefficient
No impact	0.00
It has little effect	0.25
Average impact	0.50
The impact is more than average	0.75
Strong influence	1.00

Functional suitability is an important criterion. Testing is a complex process and requires that the testing system meet all needs, meeting all user needs. Functionality is strongly influenced, so the coefficient is equal to 1. The ease of use of the program depends on the speed of creation and launch of testing and the cost of staff training. All frameworks require the user to have a basic knowledge of programming languages. The program interface also has little effect on performance, but the frameworks under consideration always provide an interface that makes the developer's job much simpler.

Also, we can distinguish the criterion of "training requirements" and the criterion about ease of use, which have an impact above average with a factor of 0.75. Plus, an important criterion for buying products online is the security of the application, namely data privacy. Users of the system should not hesitate to fill in the fields with personal information. The coefficient of this criterion has a strong influence, so we have 1. Today nothing stands still, so online stores are constantly updated. Therefore, an essential criterion for assessing the quality of the framework is the ability to modify in the future already

Table 3 – Comparison of the functionality of Back-End frameworks for the organization of e-commerce solutions

Producer	PCM	B2C	B2B	WCMS	Mobile	Print	Call center
SAP Hybris	+	+	+	+	+	+	+
IBM	+	+	+	+	+	–	+
Oracle ATG	–	+	+	+	+	–	+
Demandware	–	+	–	–	+	–	–
Heiler	+	–	–	–	–	–	–
Magento	–	+	+	+	+	–	–

written code. This criterion has a greater than average effect with a coefficient equal to 0.75. Most developers use JIRA to develop their products, or, given that the application will be developed for e-commerce, you need the ability to integrate with different systems to pay for the order. Therefore, the possibility of integration has an average coefficient of 0.50. The web application is developed for use on a single server and is used by a large number of clients, so it does not require development for different operating systems. But sometimes servers can be updated, so portability or compatibility has little effect with a factor of 0.25. Because e-commerce applications need to do it 24/7, you need a high-performance framework. Therefore, performance has an above-average impact, and its scope is 1. The last criterion for using frameworks is its price. This criterion is not imperative, because web-applications usually offer those online stores that can afford the cost of the framework. The same coefficient has a small impact and is equal to 0.25.

We pass to the last stage of calculation of the quality of frameworks. After defining the main criteria and providing them with the appropriate coefficients, it is necessary to evaluate frameworks. Each criterion has a score from 1 to 5.

Taking into account the abbreviations with meanings were presented in table 5, with the help of expert opinion, essential evaluation criteria were selected, and verbal evaluations of all considered frameworks were compared, which was presented in table 6.

Table 5 – Meanings of abbreviations

Abbreviation	Meaning
C1	Functional suitability
C2	Requirement for training
C3	Interface
C4	Security data
C5	Modification
C6	Integration with JIRA and payment systems
C7	Compatibility
C8	Productivity
C9	Price
P1	Hybris
P2	IBM
P3	ATG
P4	Demandware
P5	Magento
P6	Heiler

Table 6 – Evaluation of frameworks

Criterion	Coefficient	P1	P2	P3	P4	P5	P6
C1	1.00	5	3	5	4	5	3
C2	0.75	3	2	3	3	4	3
C3	0.75	5	2	1	5	5	3
C4	1.00	5	5	5	5	5	5
C5	0.75	5	5	5	5	3	5
C6	0.50	4	4	3	5	4	1
C7	0.25	4	5	5	5	3	5
C8	1.00	5	4	3	2	5	5
C9	0.25	2	1	5	1	1	2

To calculate the overall quality assessment of frameworks, we should use formula 3 that was presented below:

$$Total = \frac{\sum_{i=1}^{n} k_i C_i}{n} \quad (3)$$

where k_i – a criterion coefficient;

C_n – a criterion;

n – total number of criteria.

The total assessment of each of the criteria was given in the table 7.

Table 7 – Overall evaluation of frameworks

The name of a framework	Final assessment
Hybris	3.13
IBM	2.47
ATG	2.63
Demandware	2.75
Magento	3.00
Heiler	2.61

In this manner, based on the data given in table 6, Hybris is the framework that meets the largest number of criteria. But keep in mind that even Hybris cannot meet all the needs of any project.

Conclusions. When evaluating frameworks, it is possible to use modern models for estimating the quality of software. It is advisable to make such an assessment when choosing a framework at the beginning of web-based software development, which will improve the quality of software development and save time.

References

1. Moseley D., Baumfield V., Elliott J., Gregson M., Higgins S., Miller J., Newton D. P. *Frameworks for Thinking: A Handbook for Teaching and Learning*. Cambridge, Cambridge University Press, 2006. 378 p.
2. Clavijo D. *Web framework types*. URL: http://blog.websitesframeworks.com/2013/02/web-frameworks-types-122 (дата звернення: 19.09.2020).
3. Stanojević V., Vlajić S., Milić M., Ognjanović M. *Guidelines for framework development process.* Serbia, 2011 7th Central and Eastern European Software Engineering Conference (CEE-SECR), 2011, №12692778. P. 1–9.
4. S. Bhargava., P. J. Bhatewara. *Software Engineering: Conceptualize.* New Delphi, Educreation Publishing, 2018. 147 p.
5. *Official site SAP Hybris*. URL: https://www.sap.com (дата звернення: 15.09.2020).
6. *Official site Cloud IBM*. URL: https://cloud.ibm.com (дата звернення: 15.09.2020).
7. *Official site Oracle*. URL: https://www.oracle.com (дата звернення: 15.09.2020).
8. *Official site Salesforce*. URL: https://www.salesforce.com (дата звернення: 15.09.2020).
9. *Official site Magento*. URL: https://magento.com (дата звернення: 15.09.2020).
10. *Сравнение е-commerce платформ для интернет-магазина*. URL: http://novardis.com/press/vybor-sravnenie-platform-internet-magazina-hybris.html (дата звернення: 12.10.2020).
11. *ISO/IEC 25010*. URL: http://iso25000.com/index.php/en/iso-25000-standards/iso-25010 (дата звернення: 19.09.2020).
12. Zadeh L. A. *Fuzzy Sets. Information and control*. 1965. Vol. 8. P. 255–353.

References (transliterated)

1. Moseley D., Baumfield V., Elliott J., Gregson M., Higgins S., Miller J., Newton D. P. *Frameworks for Thinking: A Handbook for*

Teaching and Learning. Cambridge, Cambridge University Press, 2006. 378 p.
2. Clavijo D. *Web framework types*. Available at: http://blog.websitesframeworks.com/2013/02/web-frameworks-types-122 (accessed: 19.09.2020).
3. Stanojević V., Vlajić S., Milić M., Ognjanović M. *Guidelines for framework development process.* Serbia, 2011 7th Central and Eastern European Software Engineering Conference (CEE-SECR), 2011, №12692778, pp. 1–9.
4. S. Bhargava., P. J. Bhatewara. *Software Engineering: Conceptualize.* New Delphi, Educreation Publishing, 2018. 147 p.
5. *Official site SAP Hybris*. Available at: https://www.sap.com (accessed 15.09.2020).
6. *Official site Cloud IBM*. Available at: https://cloud.ibm.com (accessed 15.09.2020).
7. *Official site Oracle*. Available at: https://www.oracle.com (accessed 15.09.2020).
8. *Official site Salesforce*. Available at: https://www.salesforce.com (accessed 15.09.2020).
9. *Official site Magento*. Available at: https://magento.com (accessed 15.09.2020).
10. *Sravnenie e-commerce platform dlya internen-magazina* [*Comparison of e-commerce platforms for online shopping*]. Available at: http://novardis.com/press/vybor-sravnenie-platform-internet-magazina-hybris.html (accessed 12.10.2020).
11. *ISO/IEC 25010*. Available at: http://iso25000.com/index.php/en/iso-25000-standards/iso-25010 (accessed 19.09.2020).
12. Zadeh L. A. *Fuzzy Sets. Information and control*. 1965, vol 8, pp. 255–353.

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