

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV**

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UDC 004.58+005+378.4

PHD THESIS

**MODELS AND METHODS OF MANAGING JOINT UKRAINIAN-CHINESE
INTERNATIONAL PROJECTS BASED ON AGILE METHODOLOGY**

122 Computer Science
12 Information Technology

Applying for the Doctor of Philosophy degree

The PhD Thesis contains the results of own research. The use of ideas, results and texts of other authors are linked to the corresponding source

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KYIV – 2023

SUMMARY

Zhu Ting. Models and methods of managing joint Ukrainian-Chinese international projects based on Agile methodology. – *Qualifying scientific work as a manuscript.*

Thesis for the Doctor of Philosophy Degree in Specialty 122 «Computer Sciences». – Taras Shevchenko National University of Kyiv, Kyiv, 2023.

Abstract content The dissertation is devoted to the creation of scientific-methodical and information-applied support based on information and communication technologies and Agile methodology, which can be applied in international Ukrainian-Chinese projects to model the progress of the life cycle of projects and provide a timely assessment of the effectiveness of these projects for their institutional participants, administration systems and executors.

Global changes that have recently taken place in the world economy as a result of the intensive development of information and communication technologies and systems have led to the transformation of the business environment and accelerated the process of transition from an industrial to an information society. In order to intensify the implementation of changes, it is necessary to carry out scientific-analytical, methodical and applied adaptation of information architecture capabilities and functional advantages of the Agile platform, which provides management capabilities to the needs of the cycle organization and administration of the environment of international educational and information projects, taking into account the divergence/convergence of mutual influences of external entities and internal environments of the specified projects. Projects of this nature must be carried out taking into account the sustainable development of educational environments that ensure the growth of the target functional quality for the course of educational and scientific processes in higher educational institutions.

For the high-quality implementation of the project, it is necessary to understand the basic principles and take into account both external and internal influencing factors for the primary organization of decisions on the coordination of the environment and activities of participants in international projects using ICT & Agile, to achieve a

rational compromise between the complexity of the development and the "value of the user story"; improving the quality and reducing the duration of feedback.

For the successful direction of the project based on the Agile methodology, it is necessary to combine methodological components: functionally oriented development (FDD), an iterative approach without functional specifications (Getting Real), Scrum rules for managing development and coding processes, Software Development approaches, methodological components of educational management and marketing, conceptual foundations of convergence theory, stakeholder theory, and project core values.

The idea of creating an adapted administration technology and flexible adjustment of the content and characteristics of an international educational project makes it possible to use diverse specialists assigned to leading managerial roles without a clear division into formal internal specializations.

In this work, an important task is solved, namely the construction of an integrated communicative and informational environment that provides content-process and transformational paradigms for the management of international educational, educational-informational and informational-product projects that contribute to the sustainable development of educational environments and ensure the growth of the target functional quality for the course educational and scientific processes in higher educational institutions.

The object of research is the processes of managing content, environment and participants based on information and communication technologies and Agile methodology.

The subject of research is models, methods and information and communication technologies of administration of international educational and scientific projects.

Research methods. Reasonableness of the results obtained in the work was ensured by a rational combination of approaches of models and research methods, information and information and communication technologies, which are different in terms of content and purpose. The leading general-methodological components of the research, which further determined the course of the research and its results, were

chosen: Agile methodology as a modern applied embodiment of ICT; methodological principles of goal structuring and administration of educational and scientific projects; simulation modeling in an objective digital environment. As accompanying methodical components that allowed to solve the tasks, the basis of a variety of expert evaluations was used, which allows to analyze according to the degree of importance of information in any direction of information and communication technologies, so that it is possible to present complex and mutual relations of constant and variable factors, which are based on further decision-making when calculating break-even points. Methods of the theory of sets, relations and formal systems for building formal models of knowledge presentation in the management of international educational scientific projects.

The study aims of the research is to create scientific-methodical and information-applied support for the use of information and communication technologies based on the updated Agile methodology in international Ukrainian-Chinese projects.

The scientific novelty of the obtained results:

- for the first time, the scientific-analytical, methodical and applied adaptation of information architecture capabilities and functional advantages of the Agile platform to the needs of the cycle organization and environment administration of international educational and information projects, taking into account the divergence/convergence of the mutual influences of the subjects of the external and internal environments of the specified projects, was carried out.

Improved:

- content-process and transformational paradigms of management of international educational, educational-information and information-product projects, which further contribute to the sustainable development of educational environments and ensure the growth of the target functional quality for the course of educational and scientific processes in higher educational institutions;

- the application of the Agile platform for the formalized description of the information and digital space of subjects, phenomena and products of international scientific

educational projects, which allows to adequately model the course of the life cycle of such projects and provide timely assessments of the effectiveness of these projects for their institutional participants, the administration system and executors;

- a mathematical model of the strategic planning of international projects in the digital space, which allows rationalizing the trajectory of the subjects of such projects, minimizing time and resource costs.

Received further development:

- a methodological and analytical approach to the transformation of the information and communication environment on the basis of the Agile platform for productively solving the tasks of marketing planning of the release program and sales forecast of educational services at the international level. The specified approach is a reaction to the progressive development trend of information and communication, cognitive, digital and management technologies, with further integration of these trends for the preparation and implementation of a multi-component educational project;

- priorities for the identification of digital strategic milestones of the international information and educational project, which will be taken into account by the temporary structure of the project administration. The specified temporary administrative structure with the use of formalized digital indicators makes it possible to choose from the presented options for the administration of the cycle of the international educational project the one that best corresponds to the strategy of "educational and scientific synergy" and, at the same time, best meets the requests of the institutional subjects of the project;

- elements of the theory of evaluation of unknown parameters of signals when interacting with the Scrum methodology based on the one-moment and multi-moment representation of random processes and the modified polynomial maximization method, which allows to ensure the performance of the final result of the cycle of the international educational and scientific project for the effective solution of applied problems in the design and research of educational programs;

- the means of successfully solving the multitasking specialized bachelor's training program "3+1" in KanbanFlow on the basis of the Agile platform, which allows you to

update curricula and integrate them as interchangeable components into the process of functioning of the higher education system.

The first chapter of the dissertation describes Agile processes and methodologies, its conceptual studies. Based on a critical analysis of basic concepts and theoretical principles, it was determined that modern information and information and communication technologies can be used for educational purposes, in particular, in international educational processes. Also, the section highlights the advantages of using the Agile platform for organization, administration and improvement of educational, preparatory, communication and logistics processes. Processes for the administration of large-scale initial projects using the Agile platform are described, which ensures adequate minimization of objective and subjective project risks through the use of "mini-cycle" iterations. Analyzed and described cycles that reflect the stages of design and administration, content, programming environment, testing and documentation.

In this section, the capabilities of information and communication technologies in an Agile environment for structuring the goals and objectives of all stages of international projects are substantiated. The considered methodology allows to implement a successful interaction between the institutional subjects of the project (from different universities), executive subjects, managers and clients based on the direct communication of IECP-PAM (International Educational and Communication Project on the Platform of Agile Methodology) subjects in a special bullpen office.

The second chapter describes simulation modeling of risk analysis, defines the basic principles for coordinating the environment and activities of participants in international projects using ICT & Agile. The priority principles of the general vision of the content and target direction of the IECP-PAM project, a clear understanding of the communication regulations between the project subjects, the flow of resources in the middle of the project's operational system, ensuring the successful prioritization of the task list, achieving a rational compromise between the complexity of the development and the "value of the user story" were studied ", improving the quality and reducing the duration of feedback. In this section, "Crystal Ball" software packages

have been developed for practical simulation modeling, which makes it possible to conduct mathematical modeling. The measures of risk regarding the probability of obtaining a negative value are described, and the assessment of competitors is determined when developing joint educational projects, which help to indicate the rather high competitiveness of the educational institution under study. A study of marketing planning of the graduation program and forecasting of the structure of educational services at the international level was conducted, which is the basis for the joint implementation of educational projects. The purpose of which is the most effective positioning of the educational product on the market and, ultimately, the most effective use of the funds invested in the project.

The third chapter of the dissertation research presents the technologies for determining the applicability of the principles and approaches of the flexible Agile methodology in an educational institution that provides a formalized description and regulation of educational, logistical, communicative, management processes based on the indicators formalized by the author of the course of the project cycle. The construction of a technology based on the capabilities of the Scrum approach is described, which allows, without a clear division into formal internal specializations, to distribute diverse specialists according to leading managerial roles: Scrum master (organizer) and Product owner. A strategy was developed for positioning all details of the marketing complex for effective positioning of educational services, namely: strategies for services, communications, distribution and pricing. The results of the evaluation of the effectiveness of the marketing complex of an educational institution presented in this section allow you to determine the potential inherent in certain educational services, to adjust the process of their provision depending on the conditions of the market environment, to identify areas of improvement of individual elements of the marketing complex, and also to increase the competitiveness of universities in the field of training. specialists created on the labor market.

In the fourth chapter, a conceptual scheme of an integrated communicative information platform of international educational projects is developed. The proposed information technology was configured and applied for the needs of the

implementation of an international educational project (a joint educational project between the Black Sea National University named after Peter Mohyla and the Yanchyn Polytechnic Institute called "3+1") within the framework of substantiation of partner benchmarking models and a complex of marketing data of educational institutions. The methodological and analytical approach and ICT based on the Agile platform, introduced by the author, were applied to solve the problems of marketing planning of the graduation program and sales forecast of educational services at the international level. For the needs of the IECF-PAM international project, an integrated communication and information environment based on the following operating subsystems has been substantiated: the subsystem of the analysis of educational programs; a subsystem of administration and adjustment of educational projects and programs based on the Scrum approach methodology. This approach makes it possible to develop and prepare options for the IECF-PAM cycle, and then to present alternatives to the project for consideration by the management.

The practical significance of the obtained results lies in the fact that the methodical approach, analytical tools, and the information-application and communication environment created on their basis in the Agile format and application software products using FDD schedules and Scrum of the digital space made it possible to develop an integrated information- communication platform for initiating the preparation and implementation of international educational and scientific projects. The benefits of Agile have been systemically deepened thanks to the use of research results in the "3+1" project, the capabilities of administration specialists have been significantly deepened by the content of time and the information and communication environment of the project. A successful clearly formalized and step-by-step technology for forming and correcting the cycle of international educational projects has been introduced.

Keywords: Agile methodology, educational projects, information and application support, information and communication technologies, international Ukrainian-Chinese projects; virtual university; project management.

LIST OF PUBLICATIONS OF THE APPLICANT BY PHD THESIS TOPIC

Articles in professional publications of Ukraine

(included in the list of the Ministry of Education and Science of Ukraine)

1. **Zhu, Ting.** (2020). The application of Agile's flexible methodology in planning a joint international specialist training program. *Management of Development of Complex Systems*, 41, 156 – 162, dx.doi.org\10.32347/2412-9933.2020.41.156-162. [category «B»] <http://mdcs.knuba.edu.ua/article/view/203823>
2. **Zhu, Ting.** (2019). Technologies of organization of the communication process in educational projects and programs. *Management of Development of Complex Systems*, 37, 132 – 137, dx.doi.org\10.6084/m9.figshare.9783140. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-37/23.pdf>
3. **Zhu, Ting.** (2022). Methodology of partner benchmarking during the development of international joint educational projects based on Agile methodology. *Management of Development of Complex Systems*, 50, 93–101. dx.doi.org\10.32347/2412-9933.2022.50.93-101. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-50/93-101.pdf>
4. **Zhu, Ting.** (2022). Definition and evaluation of competitors in the development of international joint educational projects. *Management of Development of Complex Systems*, 51, 122–129. dx.doi.org\10.32347/2412-9933.2022.51.122-129. <http://urss.knuba.edu.ua/files/zbirnyk-51/122-129.pdf>

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1. **Zhu Ting.** (2020). Using the principles and approaches of flexible methodology (Agile) in the planning and implementation of the educational process. *Science Journal Innovation Technologies Transfer*. 48-55. 10.36381/iamsti.4.2020.48-55.

Approbation works

1. **Zhu Ting.** (2018). Strategy to increase the competitiveness of the university and its educational services. *V міжнародна науково-практична конференція «Інформаційні технології та взаємодії»*, 64-65.

2. **Zhu Ting.** (2019). Organization of the communication process in education projects. «Управління проектами у розвитку суспільства», 63-64.
3. **Zhu Ting.** (2019) Communication process in educational projects. I international scientific-practical conference, *Chernivtsi IMTSK-2019 (Information Modeling Technologies, Systems and Complexes)*, 119-121.
4. **Zhu Ting.** (2020). Agile при плануванні спільної міжнародної програми навчання. *Seventh international scientific-practical conference «Management of the development of technologies» Topic: "Information technology development of educational content» Kyiv, 25 – 26 March 2020, 145-146.*

АНОТАЦІЯ

Чжу Тін. Моделі та методи управління спільними українсько-китайськими міжнародними проектами на основі методології Agile. – – Кваліфікаційна наукова праця на правах рукопису.

Дисертація на здобуття наукового ступеня доктора філософії за спеціальністю 122 «Комп'ютерні науки» – Київський національний університет імені Тараса Шевченка, Київ, 2023.

Зміст анотації. Дисертація присвячена створенню науково-методичного та інформаційно-прикладного забезпечення, що ґрунтується на інформаційно-комунікативних технологіях і методології Agile, та може бути застосованим в міжнародних українсько-китайських проектах для моделювання ходу життєвого циклу проектів та надання своєчасної оцінки результативності цих проектів для їх інституційних учасників, системи адміністрування та виконавців.

Глобальні зміни, які відбулися останнім часом у світовій економіці внаслідок інтенсивного розвитку інформаційних та комунікаційних технологій та систем, призвели до трансформації бізнес-середовища, прискорили процес переходу від індустріального до інформаційного суспільства. Для активізації впровадження змін необхідно здійснювати науково-аналітичну, методичну та прикладну адаптацію можливостей інформаційної архітектури та функціональних переваг платформи Agile що надає можливості управління до

потреб організації циклу та адміністрування середовищем міжнародних освітньо-інформаційних проєктів, з врахуванням дивергенції/конвергенції взаємних впливів суб'єктів зовнішнього та внутрішніх середовищ зазначених проєктів. Проєкти такого характеру потрібно виконувати з врахуванням сталого розвитку освітніх середовищ що забезпечують зростання цільової функціональної якості для перебігу освітнього та наукового процесів у вищих навчальних закладах.

Для якісної реалізації проєкту необхідно вибачити базові принципи та врахувати як зовнішні так внутрішні фактори впливу для первинної організації рішень по координації середовища та діяльності учасників в міжнародних проєктах з використанням ІКТ& Agile, для досягнення раціонального компромісу між складністю розробки та «цінністю користувальницької історії»; поліпшення якості та скорочення тривалості зворотнього зв'язку.

Для успішного спрямування проєкту на ґрунті Agile методології необхідно сполучити методичні компоненти: функціонально-орієнтована розробка (FDD), ітеративний підхід без функціональних специфікацій, (Getting Real), правила Scrum управління процесами розробки та кодування, підходи Software Development, методологічні складові освітнього менеджменту і маркетингу, концептуальні засади теорії конвергенції, теорії стейкхолдерів та ядра цінностей проєкту.

Ідея створення адаптованої технології адміністрування та гнучкого коригування змісту та характеристик міжнародного освітнього проєкту дозволяє без чіткого розподілу на формальні внутрішні спеціалізації використовувати різнопланових фахівців, що розподіленні за провідними управлінськими ролями.

В даній роботі вирішується важливе завдання, а саме побудова інтегрованого комунікативно-інформаційного середовища яке забезпечує змістовно-процесну та трансформаційну парадигми управління міжнародними освітніми, освітньо-інформаційними та інформаційно-продуктовими проєктами, що сприяють сталому розвитку освітніх середовищ та забезпечують зростання цільової функціональної якості для перебігу освітнього та наукового процесів у

вищих навчальних закладах.

Об'єктом дослідження є процеси управління змістом, середовищем та учасниками на ґрунті інформаційно-комунікативних технологій та Agile методології.

Предметом дослідження є моделі, методи та інформаційно-комунікативні технології адміністрування міжнародними освітньо-науковими проектами.

Методи дослідження. Належну обґрунтованість одержаним в роботі результати забезпечило раціональне сполучення різних за змістом та призначенням підходів моделей та методів дослідження, інформаційних та інформаційно-комунікативних технологій. Провідними загально-методичними компонентами дослідження які надалі обумовили хід дослідження та його результати обрано: методологія Agile як сучасне прикладне втілення ІКТ; методологічні засади структуризації цілей та адміністрування освітньо-науковими проектами; імітаційне моделювання в предметному цифровому середовищі. В якості супровідних методичних компонент що дозволили вирішити поставленні завдання, використано основи різновиди експертних оцінювань який дозволяє аналізувати за ступенем важливості інформацію в будь-якому напрямку інформаційно-комунікативних технологій, щоб можна було представити складні і взаємні співвідношення постійних і змінних чинників, на яких ґрунтуються подальше прийняття рішень при розрахунків точок беззбитковості. Методи теорії множин, відношень та формальних систем для побудови формальних моделей подання знань в управлінні міжнародними освітніми науковими проектами.

Метою дослідження є створення науково-методичного та інформаційно-прикладного забезпечення застосування інформаційно-комунікативних технологій на ґрунті оновленої методології Agile в міжнародних українсько-китайських проектах.

Наукова новизна отриманих результатів:

- вперше здійснено науково-аналітичну, методичну та прикладну адаптацію можливостей інформаційної архітектури та функціональних переваг

платформи Agile до потреб організації циклу та адміністрування середовищем міжнародних освітньо-інформаційних проєктів, з врахуванням дивергенції/конвергенції взаємних впливів суб'єктів зовнішнього та внутрішніх середовищ зазначених проєктів.

Удосконалено:

- змістовно-процесну та трансформаційну парадигми управління міжнародними освітніми, освітньо-інформаційними та інформаційно-продуктовими проєктами, що в наступному сприяють сталому розвитку освітніх середовищ та забезпечують зростання цільової функціональної якості для перебігу освітнього та наукового процесів у вищих навчальних закладах;

- застосування платформи Agile для формалізованого опису інформаційно-цифрового простору суб'єктів, явищ та продуктів міжнародно-наукових освітніх проєктів, що дозволяє адекватно моделювати хід життєвого циклу таких проєктів та надавати своєчасні оцінки результативності цих проєктів для їх інституційних учасників, системи адміністрування та виконавців;

- математичну модель стратегічного ціле покладання міжнародних проєктів в цифровому просторі що дозволяє раціоналізувати траєкторію руху суб'єктів таких проєктів, мінімізувати часові та ресурсні витрати.

Отримало подальший розвиток:

- методико-аналітичний підхід трансформації інформаційно-комунікативного середовища на ґрунті платформи Agile для продуктивного вирішення завдань маркетингового планування програми випуску та прогнозу збуту освітніх послуг на міжнародному рівні. Зазначений підхід є реакцією на прогресивній тенденції розвитку інформаційно-комунікативних, когнітивних, цифрових та управлінських технологій, з подальшою інтеграцією цих тенденцій на підготовку та впровадження мультикомпонентного освітнього проєкту;

- пріоритети вияву цифрових стратегічних віх міжнародного інформаційно-освітнього проєкту які надалі враховуються тимчасовою структурою адміністрування проєкту. Зазначена тимчасова адміністративна структура з використанням формалізованих цифрових індикаторів дозволяє з

представлених варіантів адміністрування циклу міжнародно-освітницького проекту обрати той який найкраще відповідає стратегії «освітньо-наукової синергії» та, водночас, як найкраще відповідає запитам інституційних суб'єктів проекту;

- елементи теорії оцінювання невідомих параметрів сигналів при взаємодії з методологією Scrum на основі одномоментного та багатомоментного представлення випадкових процесів і модифікованого методу максимізації поліному, що дозволяє забезпечити продуктивність підсумкового результату циклу міжнародного освітньо-наукового проекту для ефективного рішення прикладних задач при проектуванні і дослідженні освітніх програм;

- засоби успішного розв'язування мультизадачної спеціалізованої програми підготовки бакалаврів "3+1" в KanbanFlow на ґрунті платформи Agile що дозволяє оновлювати навчальні плани та інтегрувати їх як взаємозамінні компоненти до процесу функціонування освітньої системи ВНЗ.

У першому розділі дисертаційної роботи описано процеси та методології Agile, його концептуальні дослідження. На основі критичного аналізу базових понять і теоретичних засад визначено, що сучасні інформаційні та інформаційно-комунікаційні технології можуть бути використані в освітніх цілях, зокрема в міжнародних освітніх процесах. Також в розділі висвітлені переваги використання Agile-платформи для організації, адміністрування та вдосконалення освітніх, підготовчих, комунікаційних і логістичних процесів. Описані процеси адміністрування широкомасштабних початкових проектів з використанням платформи Agile, що забезпечує належну мінімізацію об'єктивних та суб'єктивних ризиків проекту через застосування ітерацій «міні-циклів». Проаналізовані та описані цикли які відображають етапи проектування і адміністрування, зміст, середовище програмування, тестування та документування.

В даному розділі обґрунтовані можливості інформаційно-комунікативних технологій в середовищі Agile для структуризації цілей та завдань всіх етапів міжнародних проектів. Розглянута методологія дозволяє реалізувати успішну

взаємодію між інституційними суб'єктами проекту (з різних ВНЗ) суб'єктами виконавцями, менеджерами та клієнтами що спирається на безпосередню комунікацію суб'єктів ІЕСР-РАМ («міжнародний освітньо-комунікативний проект на платформі методології Agile», аббревіатура від «International Educational and Communication Project on the Platform of Agile Methodology») в спеціальному офісі bullpen.

У другому розділі описано імітаційне моделювання аналізу ризиків, визначено базові принципи по координації середовища та діяльності учасників в міжнародних проектах з використанням ІКТ& Agile. Досліджено пріоритетні принципи загального бачення змісту та цільового спрямування проекту типу ІЕСР-РАМ, чітке розуміння регламенту комунікацій між суб'єктами проекту, перебігу ресурсів в середині операційної системи проекту, забезпечення успішної пріоритезації списку завдань, досягнення раціонального компромісу між складністю розробки та «цінністю користувальницької історії», поліпшення якості та скорочення тривалості зворотнього зв'язку. В даному розділі опрацьовані для практичного імітаційного моделювання пакети програмного забезпечення «Crystal Ball» що дає можливість проведення математичного моделювання. Описані міри ризику щодо ймовірності отримання негативного значення, та визначено оцінку конкурентних сторін, при розробці спільних навчальних проектів, що допомагають вказати на досить високу конкурентну спроможність досліджуваного навчального закладу. Проведено дослідження маркетингового планування програми випуску та прогнозування збуду освітніх послуг на міжнародному рівні що є основою для спільної реалізації освітніх проектів. Метою якого є найбільш ефективно позиціонування навчального продукту на ринку і, в кінцевому підсумку, найбільш ефективно використати кошти, що інвестуються в проект.

В третьому розділі дисертаційного дослідження представлені технології визначення застосовуваності принципів та підходів гнучкої методології Agile в освітньому закладі що забезпечує формалізований опис та регулювання освітніх, логістичних, комунікативних, управлінських процесів на основі формалізованих

автором індикаторів перебігу проектного циклу. Описано побудову технології яка спирається на можливості Scrum підходу, що дозволяє без чіткого розподілу на формальні внутрішні спеціалізації розподіляти різнопланових фахівців за провідними управлінськими ролями: Scrum майстер (організатор) та власник продукту Product owner. Розроблена стратегія позиціонування всіх деталей комплексу маркетингу для ефективного позиціонування освітніх послуг, а саме: стратегії послуг, комунікацій, розподілу та ціноутворення. Представлені в даному розділі результати оцінки ефективності комплексу маркетингу освітньої установи дозволяють визначити потенціал, що закладений у визначених освітніх послугах, скорегувати процес їх надання в залежності від умов ринкового середовища, виявити напрямки вдосконалення окремих елементів комплексу маркетингу, а також підвищити конкурентоспроможність ВНЗ у сфері підготовки, створених на ринку праці спеціалістів.

В четвертому розділі розроблена концептуальна схема інтегрованої комунікативної інформаційної платформи міжнародних освітніх проектів. Запропонована інформаційна технологія була налаштована та застосована для потреб впровадження міжнародного освітницького проекту (спільного освітнього проекту між Чорноморським національним університетом імені Петра Могили та Янчинським політехнічним інститутом під назвою “3+1”) в рамках обґрунтування моделей партнерського бенчмаркінгу та комплексу маркетингу даних освітніх закладів. Запроваджені автором методико-аналітичний підхід та ІКТ на ґрунті платформи Agile були застосовані для вирішення завдань маркетингового планування програми випуску та прогнозу збуту освітніх послуг на міжнародному рівні. Для потреб міжнародного проекту ІЕСР-РАМ обґрунтовано інтегроване комунікативно-інформаційне середовище, яке спирається на наступні операційні підсистеми: підсистема аналізу освітніх програм; підсистема адміністрування та коригування освітніх проектів та програм на ґрунті методології Scrum підходу. Такий підхід дозволяє розробити, підготувати варіанти циклу ІЕСР-РАМ, далі - надати на розгляд керівництва альтернативи проекту.

Практичне значення одержаних результатів полягає у тому, що запровадженні в роботі методичний підхід, аналітичний інструментарій та створені на їх основі інформаційно-прикладне та комунікативне середовище у форматі Agile та прикладні програмні продукти з використанням FDD-графіків та Scrum цифрового простору дали змогу розробити інтегровану інформаційно-комунікативну платформу ініціювання підготовки та впровадження міжнародних освітньо-наукових проектів. Системно поглиблено переваги Agile завдяки використанню результатів дослідження в проекті «3+1» суттєво поглиблено можливості фахівців адміністрування змістом часом та інформаційно-комунікативним середовищем проекту. Запроваджено успішну чітко формалізовану та поетапну технологію формування та корегування циклу міжнародних освітніх проектів.

Ключові слова: методологія Agile, освітні проекти, інформаційно-прикладне забезпечення, інформаційно-комунікативні технологій, міжнародні українсько-китайські проекти; віртуальний університет; управління проектами.

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INTRODUCTION

In the era of the information society, along with traditional means of education, the educational potential of information and communication technologies (hereinafter - ICT) is increasingly attractive to scientists and practitioners. In the scientific environment, the phrase "information and communication technologies" carries a semantic load, which is identical to the process of systematization of methods, production processes and software and technical means, integrated for the purpose of collecting, processing, storing, distributing, displaying and using information in the interests of its users

Global changes that have recently taken place in the world economy as a result of the intensive development of information and communication technologies and systems have led to the transformation of the business environment and accelerated the process of transition from an industrial to an information society. Today, the largest part of technological developments and the field of information and telecommunication technologies is used to solve operational management tasks.

Transformations in the functioning and processing of modern international projects in the education system are largely caused by the fact that the current participants in the projects belong to an already completely new, by the nature of the relation of society, type of person - an information person. Thanks to the modern information and digital environment and ICT, the opinion is gradually forming in the minds of people that it is innovative technologies that create the necessary conditions for the formation of targeted general and special competencies required in international projects, which correspond to modern management and project thinking, as well as the value system that is generated and supported in the environment of an international project.

The following scientists Pedrosa, D., Cravino, J., Morgado, L., & Barreira, C. Maguire, P., Maguire, R., Hyland, P paid much attention to the development of information and communication technologies in scientific and theoretical and applied publications. ., & Patrick, M. Schmitz, K. Chun, A. H. W, in particular, the works of specialists such as Bohdanova M, Parashkevova E, Stoyanova M, Yaremenko L,

Ponomarenko Ya., Gerasimchuk L, Dobryanska N, Karpenko are devoted to the application of ICT in project activities N, Kovalenko O, Kramarchuk S. Saveliev E., Kurylyak V., Smalyuk G, Manokyn M., Ozhegova A, Shenkman E. Trubych S, Maikovykh T. However, recently a productive means and environment for the development of communications and educational technologies is scientific methodological and digital Agile platform. The use of ICT in educational international projects based on Agile modeling has not been properly reflected in the works of Ukrainian and foreign authors. What determines the topicality of the topic, the further choice of the purpose of the work, the object, the subject and the tasks of the research.

In this work, an important task is solved, which consists in the construction of an integrated communicative and informational environment that provides content-process and transformational paradigms for the management of international educational, educational-informational and informational-product projects that contribute to the sustainable development of educational environments and ensure the growth of targeted functional quality for course of educational and scientific processes in higher educational institutions.

The dissertation work was carried out at the Faculty of Information Technologies of Taras Shevchenko National University of Kyiv in accordance with the national strategy for the development of education in Ukraine for 2011-2027 and in accordance with the plan of research works of Taras Shevchenko National University of Kyiv, in particular the topic "Information technologies of analysis and forecasting of processes , invariant to the subject area", No. 0123U101621.

The object of research is the processes of managing content, environment and participants based on information and communication technologies and Agile methodology.

The subject of research is models, methods and information and communication technologies of administration of international educational and scientific projects.

Research methods. Reasonableness of the results obtained in the work was ensured by a rational combination of approaches of models and research methods, information and information and communication technologies, which are different in

terms of content and purpose. The leading general-methodological components of the research, which further determined the course of the research and its results, were chosen: Agile methodology as a modern applied embodiment of ICT; methodological principles of goal structuring and administration of educational and scientific projects; simulation modeling in an objective digital environment. As accompanying methodical components that allowed to solve the tasks, the basis of a variety of expert evaluations was used, which allows to analyze according to the degree of importance of information in any direction of information and communication technologies, so that it is possible to present complex and mutual relations of constant and variable factors, which are based on further decision-making when calculating break-even points. Methods of the theory of sets, relations and formal systems for building formal models of knowledge presentation in the management of international educational scientific projects.

The study aims of the research is to create scientific-methodical and information-applied support for the use of information and communication technologies based on the updated Agile methodology in international Ukrainian-Chinese projects.

The defined goal determined the need to solve the research tasks according to the following list:

1. Development of conceptual and theoretical foundations regarding the state of development of information and communication technologies, in particular regarding the Agile methodology
2. Outline the possibilities of using ICT in an Agile digital environment for structuring the goals of tasks, milestones and stages of international projects.
3. To single out the leading principles and general methodological basis for the primary organization of decisions on coordination of the environment and activities of participants in international projects using ICT & Agile
4. Development of methodological and digital principles, application of Agile methodology for simulation modeling in international educational projects
5. Development of technology using the principles and approaches of flexible

Agile methodology in an educational institution

6. Justification of models of partner benchmarking and complex marketing of an educational institution as a subject of implementation of international educational projects

7. Development of an integrated communication and information platform of international educational projects and its subsequent implementation

The scientific novelty of the obtained results:

- for the first time, the scientific-analytical, methodical and applied adaptation of information architecture capabilities and functional advantages of the Agile platform to the needs of the cycle organization and environment administration of international educational and information projects, taking into account the divergence/convergence of the mutual influences of the subjects of the external and internal environments of the specified projects, was carried out.

Improved:

- content-process and transformational paradigms of management of international educational, educational-information and information-product projects, which further contribute to the sustainable development of educational environments and ensure the growth of the target functional quality for the course of educational and scientific processes in higher educational institutions;

- the application of the Agile platform for the formalized description of the information and digital space of subjects, phenomena and products of international scientific educational projects, which allows to adequately model the course of the life cycle of such projects and provide timely assessments of the effectiveness of these projects for their institutional participants, the administration system and executors;

- a mathematical model of the strategic planning of international projects in the digital space, which allows rationalizing the trajectory of the subjects of such projects, minimizing time and resource costs.

Received further development:

- a methodological and analytical approach to the transformation of the information and communication environment on the basis of the Agile platform for productively

solving the tasks of marketing planning of the release program and sales forecast of educational services at the international level. The specified approach is a reaction to the progressive development trend of information and communication, cognitive, digital and management technologies, with further integration of these trends for the preparation and implementation of a multi-component educational project;

- priorities for the identification of digital strategic milestones of the international information and educational project, which will be taken into account by the temporary structure of the project administration. The specified temporary administrative structure with the use of formalized digital indicators makes it possible to choose from the presented options for the administration of the cycle of the international educational project the one that best corresponds to the strategy of "educational and scientific synergy" and, at the same time, best meets the requests of the institutional subjects of the project;

- elements of the theory of evaluation of unknown parameters of signals when interacting with the Scrum methodology based on the one-moment and multi-moment representation of random processes and the modified polynomial maximization method, which allows to ensure the performance of the final result of the cycle of the international educational and scientific project for the effective solution of applied problems in the design and research of educational programs;

- the means of successfully solving the multitasking specialized bachelor's training program "3+1" in KanbanFlow on the basis of the Agile platform, which allows you to update curricula and integrate them as interchangeable components into the process of functioning of the higher education system.

The first chapter of the dissertation describes Agile processes and methodologies, its conceptual studies. Based on a critical analysis of basic concepts and theoretical principles, it was determined that modern information and information and communication technologies can be used for educational purposes, in particular, in international educational processes. Also, the section highlights the advantages of using the Agile platform for organization, administration and improvement of educational, preparatory, communication and logistics processes. Processes for the

administration of large-scale initial projects using the Agile platform are described, which ensures adequate minimization of objective and subjective project risks through the use of "mini-cycle" iterations. Analyzed and described cycles that reflect the stages of design and administration, content, programming environment, testing and documentation.

In this section, the capabilities of information and communication technologies in an Agile environment for structuring the goals and objectives of all stages of international projects are substantiated. The considered methodology allows to implement a successful interaction between the institutional subjects of the project (from different universities), executive subjects, managers and clients based on the direct communication of IECP-PAM (International Educational and Communication Project on the Platform of Agile Methodology) subjects in a special bullpen office.

The second chapter describes simulation modeling of risk analysis, defines the basic principles for coordinating the environment and activities of participants in international projects using ICT & Agile. The priority principles of the general vision of the content and target direction of the IECP-PAM project, a clear understanding of the communication regulations between the project subjects, the flow of resources in the middle of the project's operational system, ensuring the successful prioritization of the task list, achieving a rational compromise between the complexity of the development and the "value of the user story" were studied ", improving the quality and reducing the duration of feedback. In this section, "Crystal Ball" software packages have been developed for practical simulation modeling, which makes it possible to conduct mathematical modeling. The measures of risk regarding the probability of obtaining a negative value are described, and the assessment of competitors is determined when developing joint educational projects, which help to indicate the rather high competitiveness of the educational institution under study. A study of marketing planning of the graduation program and forecasting of the structure of educational services at the international level was conducted, which is the basis for the joint implementation of educational projects. The purpose of which is the most effective positioning of the educational product on the market and, ultimately, the most

effective use of the funds invested in the project.

The third chapter of the dissertation research presents the technologies for determining the applicability of the principles and approaches of the flexible Agile methodology in an educational institution that provides a formalized description and regulation of educational, logistical, communicative, management processes based on the indicators formalized by the author of the course of the project cycle. The construction of a technology based on the capabilities of the Scrum approach is described, which allows, without a clear division into formal internal specializations, to distribute diverse specialists according to leading managerial roles: Scrum master (organizer) and Product owner. A strategy was developed for positioning all details of the marketing complex for effective positioning of educational services, namely: strategies for services, communications, distribution and pricing. The results of the evaluation of the effectiveness of the marketing complex of an educational institution presented in this section allow you to determine the potential inherent in certain educational services, to adjust the process of their provision depending on the conditions of the market environment, to identify areas of improvement of individual elements of the marketing complex, and also to increase the competitiveness of universities in the field of training. specialists created on the labor market.

In the fourth chapter, a conceptual scheme of an integrated communicative information platform of international educational projects is developed. The proposed information technology was configured and applied for the needs of the implementation of an international educational project (a joint educational project between the Black Sea National University named after Peter Mohyla and the Yanchyn Polytechnic Institute called "3+1") within the framework of substantiation of partner benchmarking models and a complex of marketing data of educational institutions. The methodological and analytical approach and ICT based on the Agile platform, introduced by the author, were applied to solve the problems of marketing planning of the graduation program and sales forecast of educational services at the international level. For the needs of the IECF-PAM international project, an integrated communication and information environment based on the following operating

subsystems has been substantiated: the subsystem of the analysis of educational programs; a subsystem of administration and adjustment of educational projects and programs based on the Scrum approach methodology. This approach makes it possible to develop and prepare options for the IECP-PAM cycle, and then to present alternatives to the project for consideration by the management.

The practical significance of the obtained results lies in the fact that the methodical approach, analytical tools, and the information-application and communication environment created on their basis in the Agile format and application software products using FDD schedules and Scrum of the digital space made it possible to develop an integrated information- communication platform for initiating the preparation and implementation of international educational and scientific projects. The benefits of Agile have been systemically deepened thanks to the use of research results in the "3+1" project, the capabilities of administration specialists have been significantly deepened by the content of time and the information and communication environment of the project. A successful clearly formalized and step-by-step technology for forming and correcting the cycle of international educational projects has been introduced.

The practical value is that as a result of the work, an integrated information and communication platform for initiating the preparation and implementation of international educational and scientific Ukrainian-Chinese projects was developed, which was configured and used for the needs of the implementation of the international educational project "3+1" within the framework of the justification of models partner benchmarking and educational institution marketing complex. The methodological and analytical approach and ICT based on the Agile platform, introduced by the author, were applied to solve the problems of marketing planning of the graduation program and sales forecast of educational services at the international level.

The main provisions and results of the research have been implemented and applied in Zhajiang ACME Information Technology Co. LTD. Theoretical and methodological developments have been introduced into the educational process of the Kyiv National University of Construction and Architecture.

Personal contribution of the acquirer. The dissertation is an independent scientific study. Scientific statements, results, conclusions and recommendations, which are presented in the dissertation and submitted for defense, are the result of the author's independent work. In the work [1], the author's contribution consists in formulating the general principles of setting up and solving the problem of using the KanbanFlow online tool for the needs of a joint educational project between the Black Sea National University named after Petro Mohyla and Yanchen Polytechnic Institute called "3+1". The application of the proposed approach made it possible to reduce the time spent on project management and improved the interaction of the international team, which consists of Ukrainian and Chinese specialists; the study [2] proposed international cooperation programs as a unique form of university cooperation in accordance with the needs of the labor market in various fields. In work [3], the applicant proposed a method of partner benchmarking in the development of international compatible educational projects in the form of a typology of business models, which is an assessment of the ability of an educational institution to integrate into the international educational space. The content field of the specified definitions was clarified by formulating the author's definitions of "benchmarking" and "partner benchmarking in education" and the peculiarities of partner benchmarking in education, which are caused by the differences of the educational process from the business processes of industrial enterprises and commercial organizations, were investigated in [4]. The use of principles and approaches of flexible methodology (Agile) in the planning and implementation of the educational process are considered according to the proposed author's approach in the work [5]. The materials of international conferences were also published, in which the provisions of the dissertation work are revealed in more detail [6-9].

Approbation of the results of the dissertation. The main results of the work were reported, discussed and received a positive evaluation at the international conferences "Information Technologies and Interactions", Kyiv (2018), "Project Management in the Development of Society", Kyiv (2019), "Information Modeling Technologies, Systems and Complexes", Chernivtsi (2019), "Information technology

development of educational content", Kyiv (2020).

Publications. Based on the materials of the dissertation, 9 scientific works were published, of which: 4 scientific articles in specialized publications of Ukraine, 1 article in a publication that is not included in the list of the Ministry of Education and Culture, 4 materials of international conferences. The main results of the work were obtained by the author personally. Of the scientific works published in co-authorship, the dissertation research describes those provisions that are the result of the author's personal work.

Structure and scope of work. The dissertation consists of an introduction, four chapters, chapter conclusions, main conclusions, a list of references and appendices. The total volume of the dissertation is 299 pages, of which the main part is 171 pages, including 49 figures, 15 tables, a bibliography of 192 items and 4 appendices.

LIST OF CONDITIONAL DESIGNATIONS

BCG – the method of the Boston Consulting Group

HEI – higher educational institution

SFQ - sectoral framework of qualifications

EEF - european education fund

IECP-PAM - International Educational and Communication Project on the Platform of Agile Methodology

COEP - Competency-oriented educational program

MES - Ministry of Education and Science

NFQ - national framework of qualifications

NSQ - National System of Qualifications

EP – educational program

SBU - a strategic business unit

SA EP - a system of analysis of educational programs

FDD - Feature driven development, functionality-driven development, iterative software development methodology

LMS - Learning Management System, education management system

JISE - Journal of Information Systems Education

PER - program evaluation-and-review,

SWOT-analysis - strengths, weaknesses, opportunities, threats

XP - Extreme Programming

HAPTER 1

ANALYSIS OF THE ACHIEVEMENTS OF USING THE AGILE METHODOLOGY IN TEACHING AND LEARNING

1.1 Agile processes and methodologies: a conceptual study

There are two main approaches in the software development life cycle, one is to emphasize the process and the other is to ensure the quality of the software and the process itself. Agile software processes are iterative and incremental developments where requirements change according to customer needs. It helps in adaptive planning, iterative development and timeboxing. It is a theoretical framework that facilitates the predicted interaction throughout the development cycle. There are several SDLC models such as spiral, waterfall, RAD, which have their own advantages. SDLC is a structure that describes the activities performed at each stage of the software development life cycle [10]. Software development activities such as planning, analysis, design, coding, testing, and maintenance that must be performed according to customer requirements. It depends on different applications to choose a specific model. The Agile process itself is a software development process [11]. The Agile process is an iterative approach in which customer satisfaction is the highest priority because the customer is directly involved in evaluating the software [12]. And most importantly, due to its significant advantages and adaptability to the customer, the Agile methodology can be used in other projects that are not related to software development. In Fig. 1.1 depicts the software development life cycle of Agile processes.

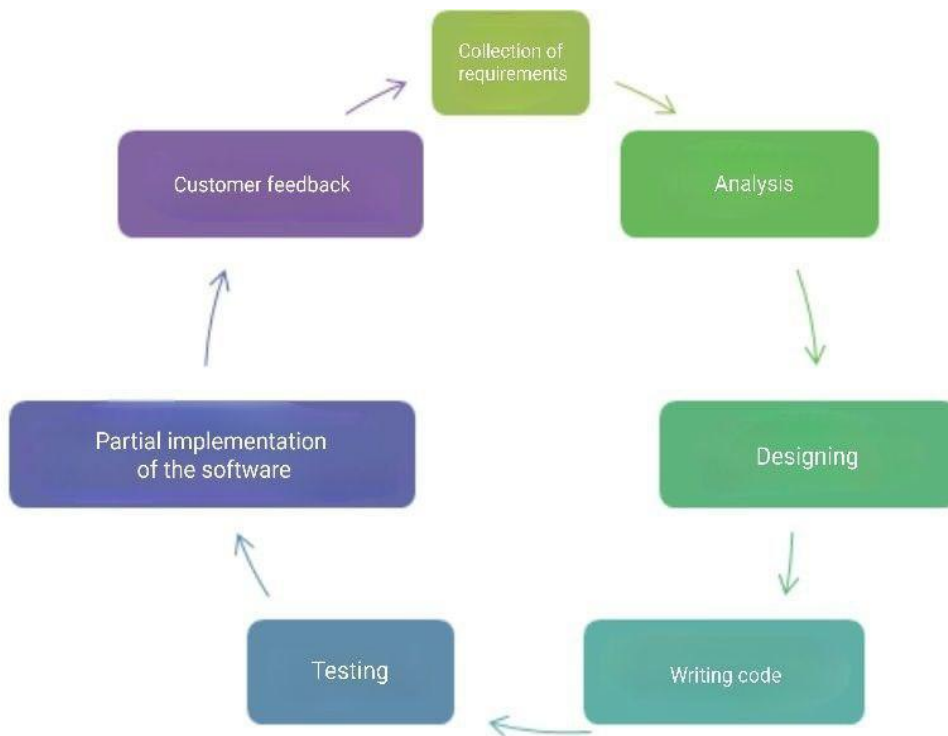


Fig. 1.1. Phases of Agile processes

The agile process follows the software development life cycle, which includes collection, analysis, development, coding, testing and delivery of partially implemented software and expects feedback from the customer. Throughout the process, customer satisfaction is the highest priority with fast development times.

1.2 Characteristics of flexible projects

An active process requires less planning and divides the task into small steps. The Agile process is designed for short-term projects with teamwork efforts that follow the software development life cycle. The life cycle of software development includes the following stages:

1. Collection of requirements
2. Analysis
3. Design
4. Coding

5. Testing

6. Service

Bringing software managers to customers reduces software risks. It is an iterative process in which changes can be made according to customer satisfaction. In agile processes, new features can be easily added through multiple iterations.

1. Iterative

The main goal of agile software processes is to meet customer needs, so it focuses on a single requirement with several iterations.

2. Modularity

The Agile process breaks down the entire system into manageable parts called modules. Modularity plays an important role in software development processes.

3. Timebox

Because the Agile process is iterative in nature, it requires time constraints for each module with a corresponding cycle.

4. Thrift

In agile processes, frugality is needed to mitigate risks and achieve goals through the minimum number of modules.

5. Increment

Because an agile process is iterative in nature, it requires that the system evolve in increments, each increment independent of the others, and finally all the steps are integrated into the complete system.

6. Adaptive

Due to the iterative nature of the flexible process, new risks may arise. The adaptive characteristic of a flexible process allows you to adapt processes to attack new risks and allows changing requirements in real time.

7. Convergent

All risks associated with each increment are converged in flexible processes using an iterative and incremental approach.

9. Joint work

Because the agile process is modular in nature, it requires good communication between the software development team. Different modules must be integrated at the end of the software development process.

10. People-oriented

In agile processes, customer satisfaction is the first priority over technology and process. A good software development team increases the productivity of the software.

1.2.1 Agile methodologies

There are several methodologies by which we can implement agile projects. Three techniques that are most widely used in industry. Agile methods focus on various aspects of the software development life cycle. Some focus on practice (extreme programming, pair programming), others on software project management (approach to approval).

A. Extreme Programming (XP)

XP is the most successful agile software development method because of its focus on customer satisfaction. XP requires maximum customer interaction for software development. It divides the entire software development life cycle into several short development cycles. It incorporates changes or customer requirements at any stage of the development life cycle.

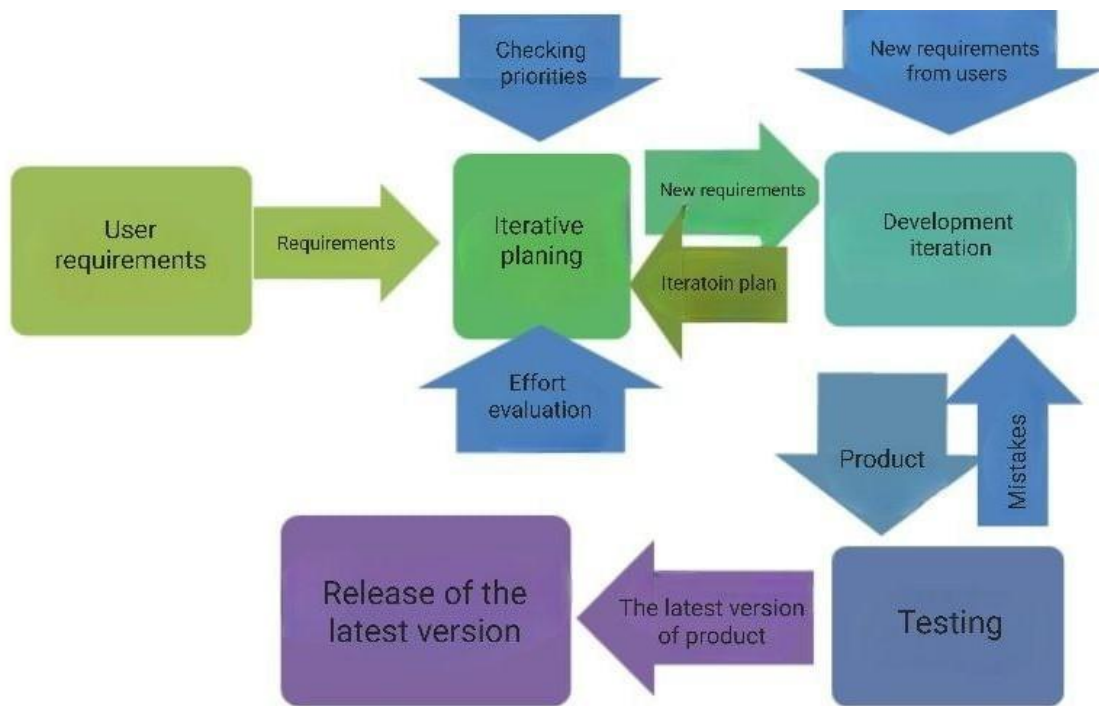


Fig 1.2: Agile process development method using extreme programming

The diagram above shows a complete method for developing an agile process using the XP method. Extreme programming starts with gathering user requirements. Depending on these requirements, the entire development process is divided into several small cycles. Thus, the next stage is iterative planning, i.e. defining the cycle of absence, prioritizing requirements and estimating the amount of effort required to implement each cycle. The next step is to test the latest developed version for bugs, if any; errors will be removed in the next iteration. After each test, follow-up should be conducted, in which feedback is taken from the project about how much work has already been done.

XP introduced a lot of new things to developers, such as pair programming, advanced code review, code refactoring, and an open workspace [13].

B. Scrum

Scrum is another popular agile development method that makes productivity very high. It is mainly based on the incremental software development process. In the scrum

method, the entire development cycle is divided into a number of iterations, where each iteration is called a sprint. The maximum sprint duration is 30 days.

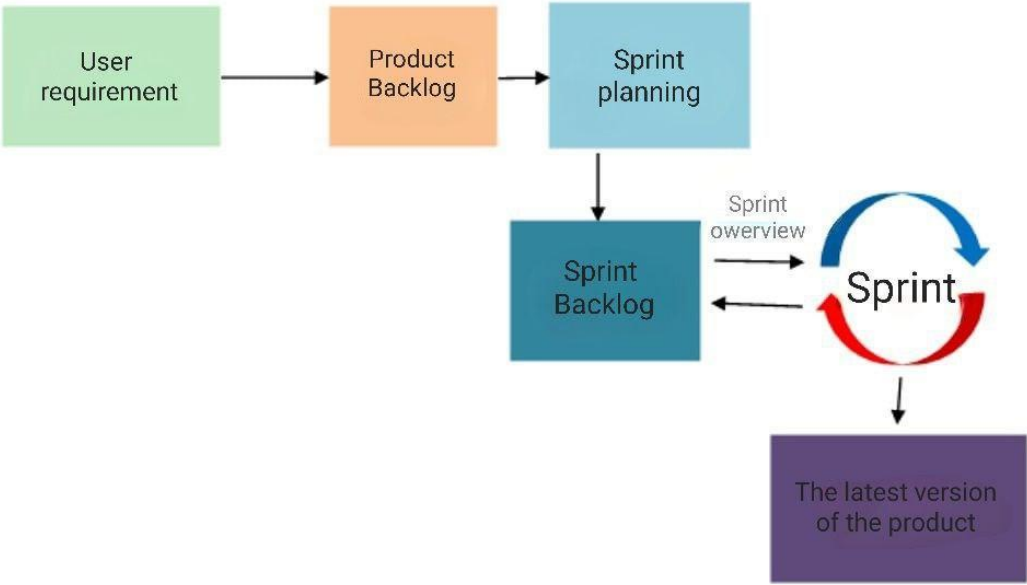


Fig. 1.3: Agile process development method using Scrum

The method starts by collecting user requirements, but it is not expected that all requirements must come from the user at the beginning. The user can change his mind at any time during development; they may add new features, remove or update some existing features. The next step is to prioritize the requirements and the list is known as the product backlog [14]. Proper planning for the sprint should be done, i.e. how many sprints are required for software development, the duration of the sprint, and what requirements from the product backlog should be implemented in each sprint. This particular list is called the Sprint Reserve. During each sprint, one sprint meeting is held daily to get feedback on how much work has been done. After each sprint review, a decision is made as to whether all requirements for that sprint have already been implemented or not, and to decide which requirements should be implemented in the next sprint. After each sprint, we receive a working software increment.

C. Designed with Functions (FDD)

FDD is one of the flexible development methods. The main advantage of this method is the development of the software domain, which must be created before the

development of the product itself.

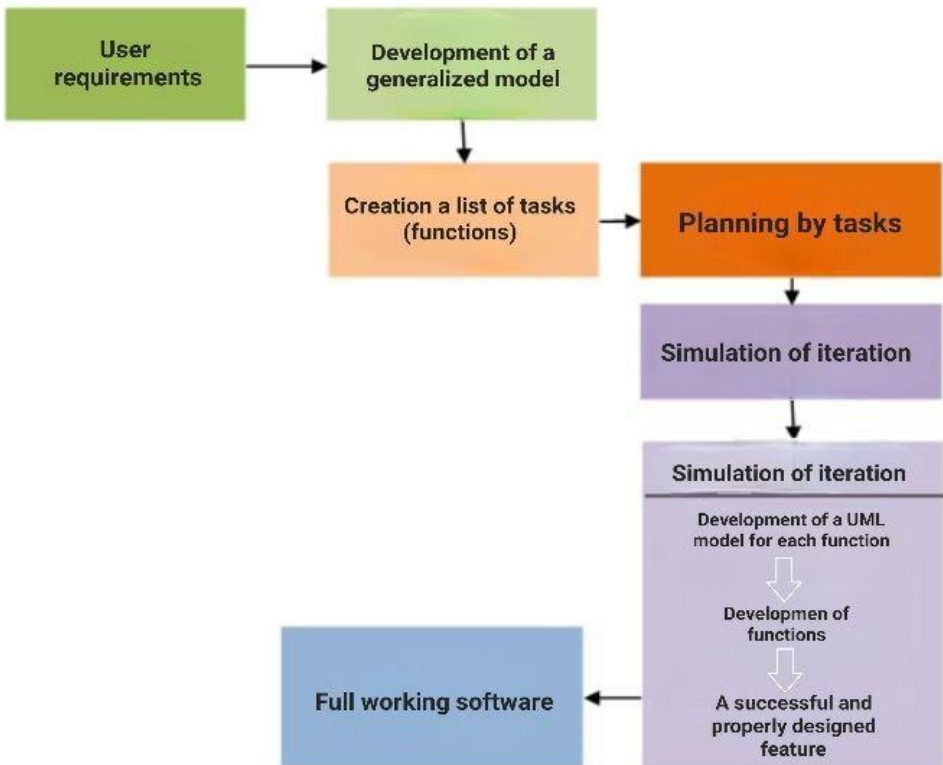


Fig. 1.4: Agile process development method using FDD schedule

The method begins with collecting requirements from users and forming a general project model. The model gives a clear idea of the scope of software application. The next step is to compile a list of features that are functions valued by the client [14]. For example, "authenticate password", "calculate salary for each employee", "calculate income tax for each employee". Now several feature groups are made on the basis of their domains, that is, related features are combined into one group. The next step is to make a feature development plan. Each feature group is assigned to a development team led by one lead programmer. The final step is the modeling iteration, in which a first UML simulation is performed for each feature, and then that particular feature is developed. This step continues if all functions are not implemented successfully.

1.2.2 Advantages of Agile

1) Adaptation to a changing environment: In an agile software development

method, software is developed over several iterations. Each iteration is characterized by analysis, design, implementation and testing. After each iteration, a mini-project is delivered to the customer for their use and feedback. Any changes that improve the software are agreed with the customer at any stage of development and the necessary changes are made.

2) Ensures customer satisfaction: this methodology requires active involvement of consumers throughout development [15]. The results developed after each iteration, provided to the user for use and improvement, are made only on the basis of feedback from the client. In this way, we get a high quality end product and this ensures customer satisfaction as the entire program is developed based on the requirements taken from the customer.

3) Least Documentation: Documentation in Agile methodology is short and to the point, although it depends on the agile team. They generally do not document the internal design of the software. The main things that should be on the documentation are the list of product features, the duration of each iteration and the date. This concise documentation saves development time and delivers the project in the shortest possible time.

4) Reduces development risk: Because incremental software is delivered to customers after each short development cycle and customers receive feedback, it alerts developers to future problems that may arise in later stages of development. It also helps to detect errors quickly and they are fixed immediately.

1.2.3 Disadvantages of Agile

1) Customer engagement is key to successful software development: Agile methodology is based on customer involvement, as the entire project is designed according to customer requirements. Therefore, if the customer's representative does not know about the features of the product, the development process will go off schedule.

2) Lack of documentation: Although minimal documentation saves development

time as an advantage of the agile method, on the other hand, it is a major disadvantage for the developer. Here, the internal design changes again and again based on user requirements after each iteration, so it is not possible to maintain detailed design and implementation documentation through the project term [16]. Therefore, with less information available, it is very difficult for new developers who join a development team at a late stage to understand exactly what method is used to develop the software.

3) Labor and resource wastage due to constantly changing requirements: If customers are not satisfied with the partial software developed by a certain iteration and they change their requirements, then this increased part is not used. So, a total waste of time, effort and resources needed to develop this growth.

4) More useful for management than for developers: Agile methodology helps management make software development decisions, set goals for developers, and fix their deadlines. But for developers of baselines, it is very difficult to cope with an ever-changing environment.

Table 1.1. Comparison of the Agile process with other SDLC models

Features	Different Process Models		
	<i>Agile Process</i>	<i>Spiral Model</i>	<i>RAD Model</i>
Definition	Agile process is the ability to both create and respond to changing requirements of software.	Spiral model is the software development model which focuses on managing risks.	RAD model is "high speed adaptation of linear sequential model, in which component based construction is used.
Adaptability	✓	✓	X
Testing Phase	Unit, Integration , System testing	Unit, Integration and System testing	Unit
Quality Factors	✓	✓	X
Risk Analysis	X	✓	X
Off-the- Tools	X	X	✓
Failure normally due to	Code	Code	Architecture and design
Knowledge Required	Product and domain	Product and domain	Domain
Entry & exit Criteria	X	X	✓
Mock up	✓	✓	X
Extendability	✓	✓	X
Project management involvement	✓	X	✓
Higher Reliability	✓	✓	X
Time Boxing	✓	X	✓

Status of Development Team	Less experience required	Less experience required	More experience required
Use of reusable components	X	X	✓
Flexibility	✓	✓	X
Customer Involvement	✓	✓	X

In a comparative study of agile software development with other software development models, we conclude that project agility is much better than other software development processes in terms of productivity, efficiency, faster cycles and risk analysis. Agile processes are implemented in critical applications such as web interface, testing tools, etc.

1.3 Agile for the development of educational programs

Around the world, educators, parents, and political leaders are working to further improve educational programs. This constant development is necessary to keep pace with the opportunities presented by technological advances, new ideas, and new knowledge about how students learn [17].

The curriculum development process is complex with many stakeholders: students, teachers, parents, administrators, employers and government. Each of the stakeholders has competing priorities; schedule, scope, quality, risks, resources and cost constraints. Large complex projects require the leadership of a qualified and experienced project manager. However, there is a gap between those working in education, with their academic knowledge, and the people who look at the performance at the end of the educational programme. This gap can be filled by professional project managers with experience in both educational programs and project and business management.

Viewing and improving educational programs as a project or program (group of projects) allows us to apply proven project management practices to manage these efforts. Choosing the right approach and methodology is critical to meeting the needs of the educational program and various stakeholders. The most common methods are; the traditional waterfall method, the Agile Project Management method or a hybrid model where both methods are used.

A traditional waterfall approach is adequate for defining, managing, and controlling scope, schedule, quality, and budget in a sustainable environment. A

waterfall approach requires a sophisticated communication plan. There are many stakeholders in the development of an educational program; students, teachers, parents, administrators, employers and government. Each of these stakeholders has its own definition of success and often has competing priorities. Add to these challenges a dynamic, fast-moving environment where student needs can change before an educational program is developed. A waterfall approach can lead to imparting outdated knowledge to students or an old methodology that does not match the new skills that new generations need.

Agile Project Management reduces complexity by breaking a longer development cycle into smaller useful segments, Agile "stories". These "stories" can be prioritized based on need, student level, environment, available resources, technology, and more. Agile also creates different "personas" for different stakeholders and analyzes the impact of the educational program before its completion.

Agile Project Management's iterative approach delivers part of the program, tests it, collects feedback, and adapts the results. This allows for the development of new educational programs for rapid adjustment and adaptation to all dynamic changes in the educational environment. With each iteration, you can apply changes based on the student's ability to understand, maximizing value. This values-based approach can lead us to invent new ways to add value to students without imparting outdated knowledge.

In 2012, a study was conducted to evaluate the use of the Agile approach to training programs [17]. A pilot educational program for schoolchildren on "project management" was developed and conducted. The first pilot project was one month long, divided into four "sprints" per week. Each "sprint" had its own set of goals. Agile "personas" were developed based on the nature of students, parents, teachers and others to know exactly how to deliver value that meets their needs.

Each week, curriculum and exercises were developed and implemented based on feedback from students, parents and the team from the previous week. The Agile approach enabled feedback to be quickly incorporated and a new program to be tested and evaluated weekly.

The team did a second test. The pilot project used students attending the circus as

a project topic, the second program used the creation of a Lego educational kit as a project topic. This made it possible to further test the approach. The Agile Project Management test was performed with the same approach in different countries, each time the team changed value without compromising quality. This is one of many examples of using Agile Project Management in education.

Working on these test projects was a learning journey for the students and the test team. After completing these test projects, it was concluded that Agile methodology can be used to manage any educational project. Agile allows you to start earlier and adapt quickly. The methodology creates an environment that encourages an open approach, demanding new ideas and options. She builds a strong team that believes in value.

The Agile Project Management approach is well suited to the development of educational programs. It is important that project, program and portfolio managers provide academic and educational staff with information about new Agile tools and technologies. Project managers, when developing any new educational program, should consider an Agile approach or a hybrid approach to deliver real and renewed value to learners.

1.4 Agile in teaching and learning: conceptual foundations and scientific program

The concept of using Agile as an approach to teaching and learning is not new [18-23]. However, while related articles appear periodically in publications such as the Journal of Information Systems Education (JISE) and other educational publications in the field of information systems, there are very few sources where such materials are systematized and conveniently presented in a separate manual [24].

In one of the studies [25], 74 students of 4 groups studying the discipline "information systems" (introduction to computing, programming, analytics, and intelligent data analysis) were observed, from freshman to senior groups, and those studying IS by specialty, and those for whom it is a general course. The obtained results

indicate interesting conclusions regarding the differences between the sexes during individual and pair work; the quality of the decision, based on age, motivation, individual or pair work, and the perception of the concept of work done; and the influence of experimental parameters between the first year (introduction to computing) and the senior year (data mining). The authors suggest that pair programming may not necessarily be a "key factor influencing attitudinal change" or "consistently associated with improved decision quality." In addition, "the type of subject is less important for improving the quality of the solution compared to the possibility of engaging in pair programming" and "perceptions of the course differ at different levels of academic preparation." The study supports the idea that pair programming can be implemented in courses outside of software development and provides a new perspective on gender differences and other activities practiced in flexible methodology can affect the improvement of the quality of the perception of the material.

Scrum is used to facilitate self-regulated learning in an introductory programming course within the Doubtfire learning management system (DLMS) [25]. The author presents an interesting, unconventional approach in contrast to the traditional approach to programming. The research aims to answer the following questions:

(1) how do students perceive an unconventional approach using Scrum to facilitate the acquisition of self-regulated learning skills?

(2) does a non-traditional Scrum-based approach improve the quality of student learning?

In particular, the study focuses on students' perception of the concepts of autonomy and competence. The measure of perceived autonomy demonstrates "that most students favor an environment that allows them to work using the Scrum approach and supports self-regulated learning," thus positively answering the first research question. In terms of perceived competence, assessment of failure rates over the past three semesters shows that the non-traditional approach did not improve student performance. In conclusion, the author states that "while this unconventional approach benefited self-regulated learners, it did not improve the motivation of disengaged learners and had no positive effect on the pass/fail ratio."

Research [26] examines the integration of Scrum principles and cooperative learning guidelines into a systems analysis and design course. In doing so, the authors hope to better promote teamwork, communication and problem solving while teaching appropriate systems analysis and design methods. This study aims to answer the following research questions:

(1) What are the levels of student achievement in systems analysis and course design that integrate learning and flexible methods through a semester-long project?

(2) What are the students' reflections on their learning and activities as a team working on a project during the semester using Agile methods?

(3) How do students perceive learning systems analysis and a course that integrates cooperative learning and flexible methods through a semester project?

Using cooperative learning as a pedagogical basis, the authors conducted research with 2 groups of 100 students each, divided into 5 teams, consisting mainly of graduates of computer and information technology majors. The first group followed a lead-in approach, while the second group followed a lag-in approach.

To solve the research questions, the authors consider three designs:

(1) the student's success in the course,

(2) student reflections on their teamwork,

(3) the student's general perception of the learning approach.

The results indicate statistically significant differences in student performance between the use of the lead-in approach and the delay-in approach, the identification of five themes related to the impact of specific students on team performance, and that the overall student perception of the learning approach was mixed between groups . The authors conclude that "Collaborative learning combined with Scrum can effectively guide students in the analysis and development of software solutions."

In 2018, an experiment was conducted: a role-playing exercise called "Scrummy" [27], which aims to help students better understand Agile project management through experiential learning. The role-playing exercise was designed as an alternative in one 2.5-hour class, two 75-minute sessions, or three 50-minute sessions. The role-playing exercise adapts the Scrum software development process in an abbreviated form, with

students working in groups of 4 to 6 to complete up to 4 sprints (30 minutes each). During the sprint, students face real-world challenges such as changing requirements and scope. Although the role-playing games were designed for health informatics students, the sample project can be easily adapted for different learning contexts. The author evaluated the effectiveness of role-playing exercises in three student classes using a combination of pretest and posttest measures of self-efficacy, as well as content-related questions. Compared to the traditional lecture method, role-playing exercises were found to produce significantly higher levels of student self-efficacy and actual understanding of Agile concepts. As a result, Schmitz concludes that this study "demonstrates the comparative effectiveness of role play over traditional reading and lecture for Agile project management concepts."

Another study [28] presents evidence of the pedagogical benefits of creating uncertainty. As part of a student information systems development course, the authors asked students to independently split into Scrum teams and complete a realistic system development project per semester. The authors deliberately integrated causes of ambiguity in the course, including minimal teacher interaction, ambiguous implementation of the target domain, a large and complex project, and changes in organizational, business, and technical conditions. At the end of the course, students completed a survey measuring uncertainty and process effectiveness. Product quality was measured using the final assessment of project results. Factor analysis revealed that students developed three different coping strategies with varying degrees of success:

(a) versatile performers step out of their Scrum role to "do what needs to be done", i.e. contribute outside of their Scrum role and beyond their area of responsibility;

(b) identified performers stepped out of their Scrum roles to "do what they know", i.e. contribute outside of their Scrum role but within their area of expertise;

(c) obedient performers stayed within their assigned Scrum roles to "do what they were told."

The findings show that obedient performers improved significantly in terms of

process performance and product quality. In other words, "students who strictly adhered to Scrum guidelines and practices were better equipped to deal with changes in requirements and other sources of uncertainty." As a result, instructors should emphasize the importance of a narrow Scrum methodology, especially if students are inexperienced in applying Scrum.

As Agile continues to gain popularity in industry, the challenge for information systems educators is to ensure that students are well prepared for jobs where Agile becomes the predominant project delivery method. The potential of Agile methodology to improve teaching and learning is immeasurable. While previous research has combined various aspects of Agile pedagogy and Agile content, as far as is known, no systematic research has been conducted on the use of Agile for course development itself. Figure 1.5 depicts an integrated conceptual framework for Agile in teaching and learning.

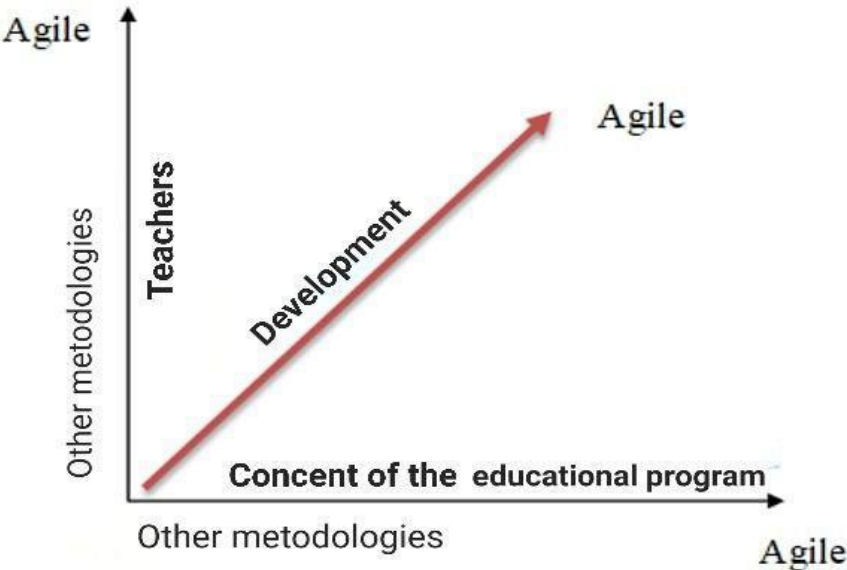


Fig. 1.5. A comprehensive conceptual framework for Agile in teaching and learning

For example, an Agile systems development course taught with student participation in Agile methods could be developed in two-week sprints with regular student feedback integrated to improve the learning experience. Essentially, the third dimension reflects the application of Agile principles at the meta level. Given that

instructors face a great deal of uncertainty about students' needs and capabilities before or at the beginning of a course, it appears that Agile principles can be useful in the course design process.

We hope this special issue inspires educators and researchers to consider integrating Agile into their teaching and learning. Although the above studies represent new contributions to our understanding of Agile in teaching and learning, it is clear that further research is needed to fully understand and apply Agile methods to design learning processes and interactions at all educational levels.

1.5. Study of the features of partner benchmarking in education

The active processes of European and world integration of Ukraine raise the requirements for the quality of domestic higher education, which has the consequence of strengthening the role of international joint educational projects for the strategic development of domestic universities. At the same time, it is not the quantity, but the quality of joint educational projects that comes to the fore, which makes the question of determining and evaluating competitors in the development of joint educational projects acutely relevant and timely.

The process of identifying and evaluating competitors, which is carried out by partners under a joint educational project, both in terms of content and methodology, is, in fact, partner benchmarking, therefore, subject to certain adaptation, classic benchmarking tools and approaches can be used for the specified purposes.

The question of determining and evaluating the competitive sides of partners for joint educational projects has not yet found sufficient coverage in domestic scientific theory, nor has it found wide practical application. However, various aspects of the introduction of benchmarking systems into domestic management practice were considered by numerous Ukrainian scientists, in particular A.H. Honcharuk [54], N.A. Dobryanska, O.M. Popovych, M.O. Vargatyuk [55], N.V. Karpenko [56], O.V. Kovalenko [57], S.P. Kramarchuk [58], D.V. Popovych, O.B. Tarnavska [59], E. Saveliev, V. Kurylyak, G. Smalyuk [60], A.S. Tolstykh [61], O.V. Khristenko, S.A.

Manzhos [62], N.M. Shved [63]. Therefore, the theoretical basis of this research is the work of domestic researchers who worked and continue to work in the field of benchmarking, in particular, partner benchmarking.

The study of the features of partner benchmarking in education, which involves, on the one hand, the definition of the meaningful field of partner benchmarking in education, and on the other hand, the methodological adaptation of existing approaches taking into account the specifics of the educational field in general and international educational projects in particular.

In order to clearly define the content field of the definition "partner benchmarking", it is first necessary to research the content field of its supercategory, since the concept of benchmarking in domestic scientific practice, in our opinion, has not yet acquired a universally recognized definition. As Tolstykh A.S. notes, some Ukrainian scientists do not clearly distinguish the concepts of "benchmarking", "competitive analysis", "marketing analysis" [61].

Let's consider some interpretations of the definition of "benchmarking" by domestic authors. So Tolstykh A.S. considers benchmarking as one of the methods of strategic planning, the purpose of which is to study and implement the best management practices, and the essence of which is to define tasks based on the reference indicators of the company's partners and competitors. A.S. Tolstykh looks at benchmarking as a systemic product of the synergy of competitive analysis, industry analysis and the strategy development process [61].

In our opinion, the definition of the concept of benchmarking through the supercategory of strategic planning methods is debatable, however, in essence, this concept does not go beyond the reference interpretation of benchmarking by F. Kotler.

N.M. Shveda, in his dissertation study, devoted to the formation of the management system of machine-building enterprises on the basis of benchmarking, considers the latter as an innovative management technology aimed at creating a continuous improvement system by the management entity in order to increase business efficiency based on original organizational, managerial, marketing and financial decisions and actions, based on a critical assessment of the external and

internal environment, as well as the experience of business practices of other successful companies in similar markets (as well as in other markets). N.M. Shveda considers benchmarking as a separate subsystem in the system of strategic management, and as its main goal determines the growth of the efficiency of economic activity and the acquisition of strategic advantages in competition [63].

Khristenko O.V. and Manzhos S.A. define benchmarking as a systematic activity that consists in studying and using the experience of leading players in a certain industry to improve the business processes and management practices of a particular enterprise and provide it with the desired market position. Such activity includes a set of tools, thanks to which it becomes possible to systematically search and evaluate the advantages of other people's experience and organize their use in the work of the enterprise [62]. This interpretation seems too narrow, since benchmarking can be carried out not only in relation to industry leaders, but also in relation to closest competitors, as well as leading enterprises from other industries.

In addition, Khristenko O.V. and Manzhos S.A. classify different approaches of foreign and domestic authors to the definition of benchmarking through the supercategories of process, tool (method, method), search, activity. At the same time, the above classification lacks a system supercategory, however, in our opinion, it is appropriate to consider benchmarking precisely as a system that allows it to be defined from the point of view of a management supersystem.

Dobryanska N.A., Popovych O.M., Vargatyuk M.O. consider benchmarking as a process of searching for a reference or standard, but more efficient, competitor enterprise, which serves as one of the quality management tools, aimed at comparing with one's own enterprise and imitating its best practices [55]. This approach is also, in our opinion, too narrow, since benchmarking can also be carried out in relation to enterprises operating in other sectors of the economy.

Taking into account the above-mentioned approaches to the interpretation of this definition, according to the authors, it is appropriate to define benchmarking as a system that is a set of tools, methods and management tools aimed at the systematic search for exemplary (or standard) management practices, business processes, products

or solutions as in industry and beyond, as well as their comparison with those available at the enterprise in order to increase the efficiency of its economic activity, improve its competitive position and increase its social significance.

Let's dwell on some interpretations of the definition of "partner benchmarking" by domestic authors.

In particular, D.V. Popovych and O.B. Tarnavska considers partner benchmarking as a complex of joint comparative studies of the economic activity of each of the partner companies, which is carried out by several partners on the basis of an agreement on benchmarking for the purpose of mutual assistance and ensuring further development for each company. Both companies from different industries and from one (i.e. competing companies) can act as partners. In the latter case, there is a softening of competition [46].

It should be noted that partner benchmarking in the above sense can act, on the one hand, as a basis, and on the other hand, as a manifestation of intra-industry clustering (especially if partner benchmarking is carried out by companies operating in the same region).

The market leader is most often used as a benchmark for partner benchmarking, however, there are also other models, in particular, a model that provides for the identification of leaders according to each of the key comparative parameters and the subsequent comparison of the relevant aspects of the activities of each of the partners with such local leaders; or determination of the most effective or innovative practices in the activities of each of the partners with their further analysis, decomposition and adaptation to the specifics of the activities of the remaining partners.

As noted by D.V. Popovych and O.B. Tarnavska, in the case when the partner group is international in nature, the general comparison should be supplemented with benchmarking of companies united by a territorial feature [55].

Like the mentioned authors, O.V. Kovalenko also shares the opinion that partner benchmarking can characterize the situation of "renouncing competition in favor of cooperation." In an article devoted to the specifics of benchmarking tools in anti-crisis management of a company, O.V. Kovalenko considers partner benchmarking as a type

of external benchmarking, which is a process of reference comparison of companies from a partner group, which can be both single-industry and multi-industry [57].

In the first case, partner benchmarking in terms of its tools and methodology will, in fact, be classic competitive benchmarking, and in the second case, it will be functional (because in this case the analysis touches on certain functions, processes, technologies and approaches that are similar in companies belonging to different industries and do not compete with each other, therefore willingly participate in joint benchmarking projects). An intermediate situation is when companies from the same industry are not direct competitors (or competition is limited) due to the influence of geographical barriers.

E. Saveliev, V. Kurylyak and G. Smalyuk define partner benchmarking as a modern form of mutual assistance and cooperation of companies and other organizational entities, which involves mutual interest of the parties and the existence of a joint agreement on conducting benchmarking studies. Its purpose is to identify, adapt and disseminate best practices among partners, as well as to provide assistance to support the development of allied companies (or other organizational entities) [60].

In our opinion, the last definition of partner benchmarking is the most complete and justified.

E. Saveliev, V. Kurylyak and G. Smalyuk pay special attention to the situation when partner benchmarking is carried out by competing companies. They justify the opinion that this type of benchmarking should become the most widespread in today's global economy, because it stimulates joint work for the purpose of ensuring sustainable development and reduces the negative aspects of competition. The retreat from competition in favor of cooperation is due to the fact that no company can be absolutely successful in all areas of its activity. This makes it expedient for the joint analytical work of the partner companies, aimed at identifying the strongest points of each of them, as well as mutual assistance in their adaptation and borrowing based on the principles of obtaining benefits from cooperation by each party. To ensure the last point, the benchmarking agreement stipulates that the results of the benchmarking study cannot be used to the detriment of the partner companies [60].

Partnership trends in the development of benchmarking at the global level have gone far beyond entrepreneurship. Partner benchmarking has made a successful expansion into the field of education, reaching the regional, national and international levels. The active use of partner benchmarking is observed in the processes of clustering and development of cooperation networks, in particular - educational ones.

To determine the definition of partner benchmarking in education, let's focus on its individual features, determined by the specifics of the specified industry.

It should be noted that, although in general, educational partner benchmarking does not go beyond industrial and commercial, methodically and methodologically it differs significantly, since the educational process, which in this case is the main object of partner benchmarking, has significant differences with commercial business processes companies. This requires a much more creative approach in the process of implementing partner benchmarking in education, which even led to the emergence of a new definition in the specified field - benchlearning - that is, benchmarking of learning, cognition, education.

A demonstrative example of the successful implementation of partner benchmarking in education is the experience of the benchmarking club of German technological universities, which was created back in 1996. As specific features of its methodology, one can note a process approach in the distribution of resources and in the management of professors and teaching staff, as well as a clear definition of the goals of the benchmarking research (analysis of the internal structure and development of activity indicators in such academic fields as chemistry, physics, mechanical engineering) [64].

A vivid example of international partner benchmarking in education was the benchmarking analysis project of the Copenhagen Business School (CBS, Denmark), implemented in 1998 in partnership with 12 other European universities in the field of management teaching. In the process of partner benchmarking, the costs per student, curricula and teaching methods, the quality of the teaching staff, the system of interaction with business, ensuring the quality of education and other indicators were compared and investigated [65].

In 2000, the international project of partner benchmarking in education brought together the University of Oulu (Finland), the University of Otago (New Zealand), the University of Venice (Italy) and Leoben (Austria). The goal of the project was to expand international cooperation in the field of teaching and curriculum development, and the research results were presented in a monograph, the authors of which used the definition of "bench learning" for the first time.

In the questionnaire of the specified international benchmarking project, 5 blocks of 6-10 questions were allocated in each. In order to illustrate the specifics of international partner benchmarking in education, we present this methodology in full:

Block 1. Study program (curriculum):

- Describe the used system of educational credits and its logic;
- What are the key learning goals? What is the vision of curricula, training programs, individual courses in relation to the scientific and professional component?
- Are separate training courses connected to each other to form educational modules? How is the sequence of courses related to the formation of the corresponding modules? What is the reasonable and logical connection between the separate parts of the training?
- Describe in general what scientific and professional skills are formed and developed during the training process? What specific skills are given special attention? Are there specific areas of expertise that the curriculum is particularly focused on? Which exactly?
- Can a student form an individual study plan? How?
- How exactly does the faculty take into account the credits received by the student in other educational institutions (study, transfer)?
- What role is assigned to specific professional qualifications (skills) in the training program? What skills are considered most important? Do students go through industrial practice during their studies?
- What role in the training program is assigned to the formation of scientific work skills? What areas of scientific knowledge (philosophy of science, methodology, etc.) are considered the most important)? To what extent can students participate in real

research projects during their studies?

Block 2. Teaching methods.

- What teaching methods are used by the teaching staff and to what extent are they justified (lectures, exercises, etc.)?

- What is the role and significance of the latest information technologies in the process of learning and teaching? What type of learning and teaching technologies are used? Is there a possibility of distance learning, Internet-oriented learning, etc.? Are certain virtual university courses organized?

- What types of exams and other evaluation methods do the faculties use? How is the assessment carried out? How are learning outcomes transformed into grades? What problems exist in the system of exams and evaluation?

- How would you describe the quality and significance of interaction between students and teachers? To what extent is this interaction realized in the educational process and in the academic campus? What kind of interaction is this?

- What new teaching methods have been recently tested and used in teaching? Are teaching development projects at the stage of consideration or implementation? What are these projects?

- Can students receive credits by participating in research projects of the faculty? Do they have the opportunity to officially teach junior students, to supervise them? How is it organized and credited?

- How is maximum student participation in education ensured? What tools are used to motivate students? Is participation in lectures (practical, laboratory, etc.) classes mandatory or voluntary?

Block 3. Processes of providing training and teaching:

- How does the quality of education improve? How does the faculty guarantee the availability of modern pedagogical (didactic) knowledge among teachers?

- Does the university organize pedagogical (didactic) training of teachers to support and develop teaching skills? How is this training organized? Do teachers want to participate in it?

- What support is provided to teachers for the preparation of quality educational material?

- How do faculties support the development of teachers' skills in using information technologies?

- How do new students get to know the faculty and the education system?

How does the faculty ensure optimal entry into studies? Is there any special training for first-year students (individual lessons, study skills development courses, etc.)?

- How is academic management organized during classes

- Are mentors or other external experts used to advise students?

- How is assistance to students in the learning process during the selection of courses and disciplines carried out?

- How is management of diploma theses organized? How much time does a student need to prepare a master's thesis?

- How is the provision of the teaching process organized? Is there a structure to support the development of teaching at the university, at the faculty, at the department?

Bock 4. Quality assurance:

- How is student progress monitored? How are the functionality and quality of the educational program evaluated?

- How is the course and discipline evaluated? Does the faculty provide feedback to students? How are student feedback analyzed, how are the results of the analysis used to improve learning and teaching?

- How is management of diploma theses organized? How much time does a student need to prepare a master's thesis?

- How is the provision of the teaching process organized? Is there a structure to support the development of teaching at the university, at the faculty, at the department?

- Does the faculty use information technology to collect and process student feedback?

- Do the offered educational programs have national or international accreditation? How is accreditation or other form of public recognition of education carried out?

- Does the university (faculty, department) use teaching quality assessment systems? What evaluation methods (self-evaluation, external evaluation, etc.) are included in such systems? How is information processed and used to improve the quality of teaching? Describe the structure and functionality of training quality assurance.

- What needs to be improved in the security system

- What needs to be improved in the quality assurance system? How are quality assurance activities evaluated and improved?

Block 5. International education:

- What strategy of internationalization of learning is used in your educational program (at your faculty)? How are internationalization of education and internationalization of research related to each other?

- How positive do teachers feel about international education (or teaching in a foreign language)?

- Are the study programs open to domestic and foreign students? Do exchange students have study programs specifically designed for them? What language are these programs implemented in?

- How is the internationalization of education used in the development or improvement of education?

- How do teaching methods and educational activities stimulate the cooperation of domestic and foreign students?

- Describe the possibilities of foreign internships for students;

- Do you organize orientation programs (initial course of the state language and national culture) for foreign students at the beginning of their studies? How are these programs implemented? [66].

Analyzing methodical approaches to conducting international partner benchmarking in education, we can note that, unlike partner benchmarking in the

production and commercial spheres, much less attention is paid to a complex of economic issues affecting market share, economic effect and efficiency, cost optimization, etc. At the same time, educational processes, their provision, their results and directions for further improving the quality of educational products come to the fore during the benchmarking analysis.

Thus, we can define partner benchmarking in education as a project of joint benchmarking research, which is a form of cooperation between educational institutions, which is carried out with the aim of identifying, adapting and spreading leading educational practices that allow to increase the level of efficiency of educational processes and the quality of educational products.

In addition to partner competitive benchmarking, universities may be involved in partner benchmarking projects of a functional nature. Mostly, it concerns non-educational cluster benchmarking projects. At the same time, universities in cluster benchmarking formations act primarily as scientific institutions, taking upon themselves the methodical and methodological support of the benchmarking project, the organization of benchmarking research and the processing of its results.

A vivid example is the international project of partner benchmarking in the field of innovation clusters, which united Germany and South Korea. The Berlin Institute of Innovation and Technology was tasked with conducting such a study. The partnership benchmarking study concerned Korean and German innovation clusters, and its results not only had a significant practical result, but also allowed for strengthening international cooperation in the field of research and innovation. For the German side, the positive effect of such cooperation was the increase in the competitiveness of German enterprises in the Asian region, and for the Korean side, the strengthening of cooperation with the EU in the field of science, innovation and education [67].

In addition, universities, acting as agents of clustering in education, science and innovation, or joining industry regional cluster formations in other spheres of activity, can themselves initiate intracluster partner benchmarking projects - both competitive and functional.

Partner benchmarking in cluster formations emphasizes slightly different aspects than partner benchmarking in education and other spheres of activity. Special attention is paid to comparative analysis of partners' priority goals, evaluation of the latest and most successful practices, development of recommendations for cooperation with state bodies and non-state funds, as well as for international cooperation and inter-cluster cooperation.

Methodologically, partner benchmarking is a study of the structure, organization, tools of activity of partner companies and the development of ways and means of its improvement by identifying, researching and adapting best practices.

From the point of view of methodology, partner benchmarking in education is process-oriented, since its object is mainly the educational process and its components. This is due to the fact that the components of the educational process may contain leading practices that can be adapted to improve the educational product and increase the level of educational effectiveness (its results). Therefore, partner benchmarking based exclusively on such objects as the educational product and learning results cannot provide a deep understanding of the means by which the success of the reference educational institution is achieved. On the other hand, in the process of conducting a benchmarking study, it is also not advisable to ignore the educational product and results, since these parameters can be used to select benchmarks and leading practices recommended for adaptation and implementation.

Partner benchmarking is a manifestation of civilized competition, which maximally meets the requirements of sustainable economic development in the conditions of the global challenges faced by humanity in recent decades. Competitive struggle in its classical form costs humanity too much, therefore partner benchmarking as a basis for competition-partnership and clustering of industries can become the basis not only for the development of individual economic entities, but also for the harmonization of industry development, as well as the sustainable development of national economies, and the global economy as a whole.

Conclusions for chapter 1.

Partner benchmarking in the field of education, in particular - international, is the basis for the development and enrichment of educational practices, their actualization in accordance with the social demands of the present and the projected future, as well as their adaptation to the extremely rapid changes taking place in the socio-economic systems of the Industry formation 4.0. The very definition and assessment of competitors within the framework of benchmarking partnership projects in education can serve as a tool for forming and adjusting the strategy of a modern university. International partner benchmarking can have a special impact on the enrichment and development of educational practices, which, on the one hand, can serve the goals of improving the national education system, and on the other hand, the goals of its internationalization and increasing the reputational component. The view of partner benchmarking in education as a way of identifying, adapting and implementing the best educational practices in order to develop the activities of a separate higher education institution, regional or national education system is too narrow. Experience in representing the best educational developments, as well as in assisting partner universities in their adaptation in accordance with regional or national specifics, is also a definitely positive result of participation in joint benchmarking projects in education. Decomposing the educational process to the smallest elements of one's own educational practices in the process of benchmarking analysis improves the understanding of one's own educational and management processes and allows to reveal hidden, implicit problems and "bottlenecks".

The direction of further research should be the development and improvement of the methodology and methodology of international partner benchmarking in education.

A critical analysis of the content of basic definitions and theoretical principles regarding the possibilities of using modern information, information and communication technologies for use in educational processes, in particular in international educational processes, was carried out. The essential advantages of using the Agile platform for the needs of training, administration and improvement of

educational, preparatory, communicative and logistical processes within the framework of the specified projects are highlighted. A significant advantage of the application of the Agile platform to the administration of international educational projects is the ability to combine: the advanced values of "software development", the values of an international project, the possibilities of extreme Scrum programming, DSDM, FDD, in addition to the application of the Agile platform within the framework of the administration of the IECP-PAM cycle "international educational and communication project on the platform of Agile methodology" (abbreviation of "International Educational and Communication Project on the Platform of Agile Methodology") ensures proper minimization of objective and subjective risks of the project through the use of iterations of "mini-cycles". In each such mini-cycle, the functional requirements of the design and administration stages, the content and programming environment, the expected format of testing and documentation, the outline of the expected software product, and the priorities that dynamically change from the previous iteration to the next are adequately described in a special informational vocabulary.

SECTION 2

MODELS AND MECHANISMS OF AGILE METHODOLOGY IN TEACHING AND LEARNING

2.1 Simulation modeling of risk analysis

Risk analysis uses information contained in a probability distribution with multiple values. The use of multiple values instead of defined probability distributions is precisely the factor that distinguishes the traditional approach from simulation modeling.

Finding random variables and assigning them the appropriate probability distribution is a prerequisite for conducting risk analysis. Having successfully completed these stages, you can proceed to the modeling stage. However, a specific transition to mathematical modeling is possible only when the correlation in the system of random variables, which was included in the mathematical model, is determined. Correlation means random dependence between variables, which is not of a strictly defined nature, for example, the dependence between the sale price of a product and the volume of sales.

The presence of correlated variables in the analysis model can seriously distort the results of the risk analysis if this correlation is not taken into account. That is, the presence of correlation limits the random selection of individual values for correlated variables. Two correlated variables are modeled in such a way that when one of the variables is randomly selected, the other is not chosen freely, but in a range of values controlled by the simulated value of the first variable.

The "model runs" stage is part of the risk analysis process. At the same time, all the mechanical work is performed by the software. When the assumptions are justified, the model is successively calculated - the so-called run. This happens until enough values are obtained to make a decision (e.g. more than 2000).

For practical implementation of simulation modeling can be recommended.

The software package "Crystal Ball" meets the tasks for conducting

mathematical modeling. This package is designed as an application for working with EXCEL spreadsheets. This package generates random numbers based on the use of a pseudo-random number sensor calculated according to a specified algorithm. The package has the ability to generate correlated random values.

As a measure of risk, you can use NPV - the probability of obtaining a negative value. This possibility is calculated based on the results of mathematical modeling as the product of the number of results with a negative value and the probability of a single run. For example, if out of 5000 runs, negative NPV values are found in 3454 cases, then the risk measure will be 69.1%.

Consider an example of using simulation modeling to analyze the risk of a fairly simple investment project (table 2.1). Instead of single-digit values of operational activity parameters, we will set uncertainty intervals, assuming a uniform probability distribution for each of the intervals.

Table 2.1. Simulation modeling for project risk analysis

<i>Parameter</i>	<i>Lower value</i>	<i>Nominal value</i>	<i>Upper value</i>
Product unit price	18	20	22
Variable costs	13	14	15
Fixed costs	270 000	300 000	330 000

Simulation modeling is developed using the Crystal Ball program. The simulation results are presented below in the form of a standard diagram for this package (Fig. 2.1).

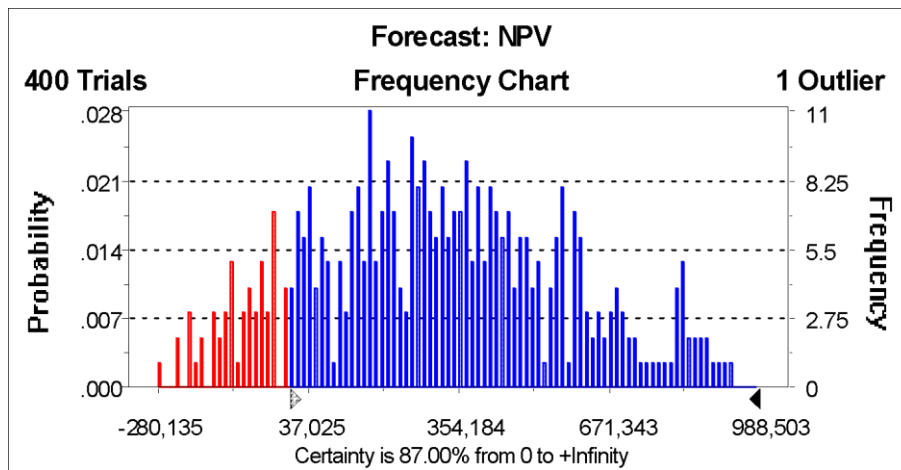


Fig. 2.1. Project risk simulation in Crystal Ball software.

Analysis of the diagram shows that the probability of a positive NPV value is 87%, that is, the degree of risk does not exceed 13%, which is obviously more than acceptable.

2.2. Calculation of the break-even point

To calculate the break-even point of an educational project, you can use a classic model for business that uses simple ratios based on the balance of revenue:

$$\text{Revenue} = \text{Variable costs} + \text{Fixed costs} + \text{Profit.}$$

For example, let the output data have the following form:

	<u>On product unit.</u>	<u>Interest</u>
Product unit price	\$5000	100 %
Variable costs	\$3000	60 %
Unit invested income	\$2000	40 %

Fixed costs are \$800,000 per year

Fig. 2.2. A classic model for calculating the break-even point for business.

If X is the break-even point in units of educational goods per student, then using the following equation we get:

$$\$5000X = \$3000X + \$800000 + \$0,$$

where $X = 400$ students (or in monetary terms: $\$5,000 \times 400 = \$2,000,000$).

A more general scheme of reasoning has the following form. Let p be the price of a unit of production, and let N be the volume of production for a certain period of time. Let's write down the main equation of the model, which symbolizes the fact that NI's pre-tax profit is determined by the total revenue minus all fixed and variable costs:

$$NI = p * N - v * N - F, \quad (2.1)$$

where F is the amount of fixed costs for a period of time;

v - the amount of variable costs per unit of production.

The break-even point by definition corresponds to the condition $NI = 0$, and accordingly:

$$BEP = F / (p - v) \quad (2.2)$$

Thus, in order to calculate the break-even point, it is necessary to divide the amount of fixed costs by the difference between the price of products and the amount of variable costs per unit of production. The latter is called unit contribution margin.

If the task is to determine the target sales volume of N_T , i.e. such value of sales volume that corresponds to the given value of profit NI_T , then we use a similar ratio

$$NI_T = p * N_T - v * N_T - F, \quad (2.3)$$

then

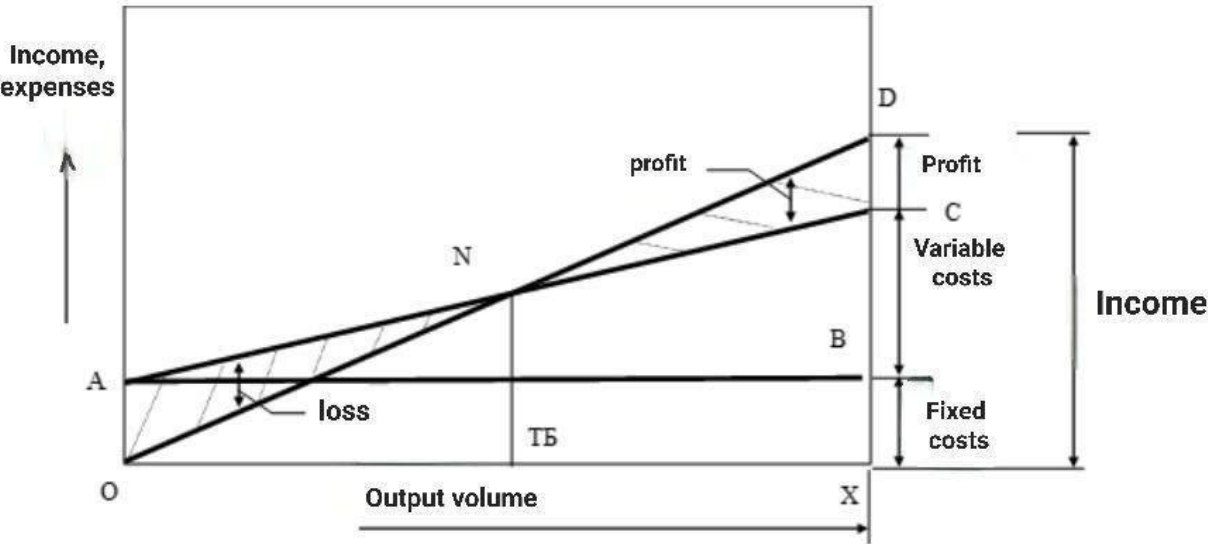
$$N_T = (F + NI_T) / (p - v) \quad (2.4)$$

An important characteristic of the successful operation of the enterprise is the size of the safety margin (Safety Margin), which is defined in a relative form as the difference between the planned sales volume and the break-even point:

$$\eta = (NT - BEP) / NT \quad (2.5)$$

The higher this indicator is, the safer the company feels before the threat of negative changes (decrease in sales volume, price reduction or increase in costs).

The essence of the break-even analysis is fully revealed on the break-even graph (Fig. 2.2). This graph shows the volume of production in physical terms on the horizontal axis and the amount of income or expenses in value terms on the vertical axis. A similar graph could be constructed by plotting the output as a percentage of full capacity on the horizontal axis.



AC - the line of total costs; OD is the income line

Fig. 2.2. Graphical representation of the break-even point

The AB line, which shows constant costs that do not change depending on the volume, runs parallel to the X axis. The vertical distance between the AB line and the AC line at any given volume characterizes the total variable costs of producing a given volume of products, and the vertical distance between OA and AC at any certain volume of production characterizes the total costs of production of this volume. When the product is not sold, aggregate costs are not equal to zero, but equal to OA. When the volume of output is equal to X, the aggregate costs are represented by the line X, which is equal to the sum of XB + BC (XB - fixed elements of costs (the same as OA) and BC - variable elements of costs). For each specific selling price of a unit of the final product, the OD line will show the amount of income at different sales volumes. The intersection of the total revenue line with the total cost line defines the break-even point (TB) "N", the point at which total revenue equals total costs (variable and fixed). Any vertical difference between the total revenue and total cost line to the right of TB

shows profit at a given output, while losses will be shown on the graph to the left of TB because in this case total cost exceeds total profit.

A feature of break-even analysis for several types of products is the combination of fixed costs in a single break-even format, as presented below.

	Product A		Product B		In total		
Receipts	\$100 000	100%	\$300 000	100%	\$400 000	100,0%	
Minus variable costs	70 000	70%	120 000	40%	190 000	47,5%	
	\$30 000	30%	\$180 000	60%	210 000	52,5%	
Invested income							
Minus fixed costs						141 750	
Minus fixed costs						\$ 68 250	

According to calculations, we get: total break-even point = $\$141,750 / 0.525 = \$270,000$

Fig. 2.3. Combination of fixed costs in a single format break-even

With a change in the structure of production and sales, the total relative invested income and the break-even point change.

	Product A		Product B		In total		
Receipts	\$300 000	100%	\$100 000	100%	\$400 000	100,0%	
Minus variable costs	210 000	70%	40 000	40%	250 000	62,5%	
Invested income	\$90 000	30%	\$60 000	60%	150 000	37,5%	
Minus fixed costs						141 750	
Minus fixed costs						\$ 8 250	

The break-even point also changes: $BEP = \$141,750 / 0.375 = \$378,000$

Fig. 2.4. Movement of the break-even point with a change in the structure of production

With the help of this format, it is possible to analyze the structure of production and sales of the enterprise and propose the most effective option, taking as a criterion the minimum value of the break-even point.

2.3 Identification and assessment of competitors in the development of joint educational projects

The evaluation of the competitive aspects of the activity of the educational institution during the development of joint educational projects aims to reveal the competitive advantages that are supported and that will be included in this project. For this, it is necessary to identify several main competitors on the market and compare your educational institution with them in different categories. An example of such an analytical approach is given in Table 2.2. The marked numbers show the assessment of the capabilities of each of the competitors in comparison with our company. In general, the data indicate a fairly high competitiveness of the studied educational institution, since the average score of the strongest competitors does not exceed 3-3.5, that is, the institution has a strong competitive position and can count on the successful implementation of the project.

Table 2.2 Strengths and weaknesses of the educational institution compared to competitors

A group of factors	Competitor				
	1	2	3	4	5
<i>1. Marketing</i>					
Quality of educational services	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Number of programs	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Differentiation of programs	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Market share	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Pricing flexibility	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Channels of recruitment of students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Promotional programs	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Services for students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Marketing researches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Advertising	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
<i>2. Innovativeness</i>					
Novelty of educational	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

plans					
Availability of information and communication support	1 2 3 4 5	1 2 3 4 5	12 3 4 5	1 2 3 4 5	12 3 4 5
<i>3. Educational process</i>					
Quality of teaching	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5	12 3 4 5
Educational facilities	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Productivity of teachers	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5
Education expenses	12 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5
Educational laboratories	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5	1 2 3 4 5
Project control	12 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5
<i>4. Human resources</i>					
Qualification of teachers	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Loyalty and satisfaction employees	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Discipline and turnover	2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Qualification of managers	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5	1 2 3 4 5
Knowledge of market economy	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5	1 2 3 4 5
Reward level	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	12 3 4 5	1 2 3 4 5

Note: 1 is the weakest position, 5 is the strongest position

Market analysis includes consumer identification and market segmentation based on differentiated consumer behavior. The selection of the market segment meets certain requirements:

- the behavior of consumers in the segment should be as uniform as possible;
- the segment must clearly differ from other segments;
- the size of the segment should be large enough so that the company operating in a differentiated market segment can recoup costs.

The main features of segmentation by consumer groups:

- geographic (region, population size and density, climate);
- demographic (age, gender, family size, marital status, level of income, education, types of professions, nationality, religion);
- psychographic (social stratum, lifestyle, personal qualities);

- behavioral (degree of randomness of purchase, search for benefits, status of regular customer, degree of need for the product and willingness to purchase it).

The listed factors, as a rule, are used in the analysis of markets in any combination and allow to draw a conclusion about the presence of a certain market segment. Then, the market potential or the maximum possible market demand is estimated from the selected segments (Fig. 2.5).

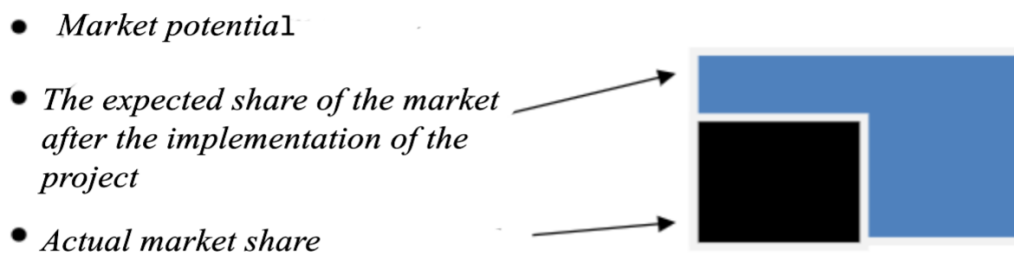


Fig. 2.5 Capacity and market share

An increase in the capacity of the future market is predicted to determine the actual or planned market share of the enterprise. The target market share provides a basis for forecasting the sales volume and therefore the production program, production capacity and certain requirements for materials, labor, investment, etc.

2.3. Marketing planning of the graduation program and sales forecast of educational services at the international level

Data from the analysis of the conditions for the implementation of the joint project are the basis for developing a marketing plan. Its goal is to most effectively position the educational product on the market and, ultimately, to most effectively use the funds invested in the project. The basis of planning is the marketing strategy adopted by the educational institution, which later, during the development of a specific project, is also specified in detailed plans and programs for each of the elements of the

marketing complex (Fig. 2.6).

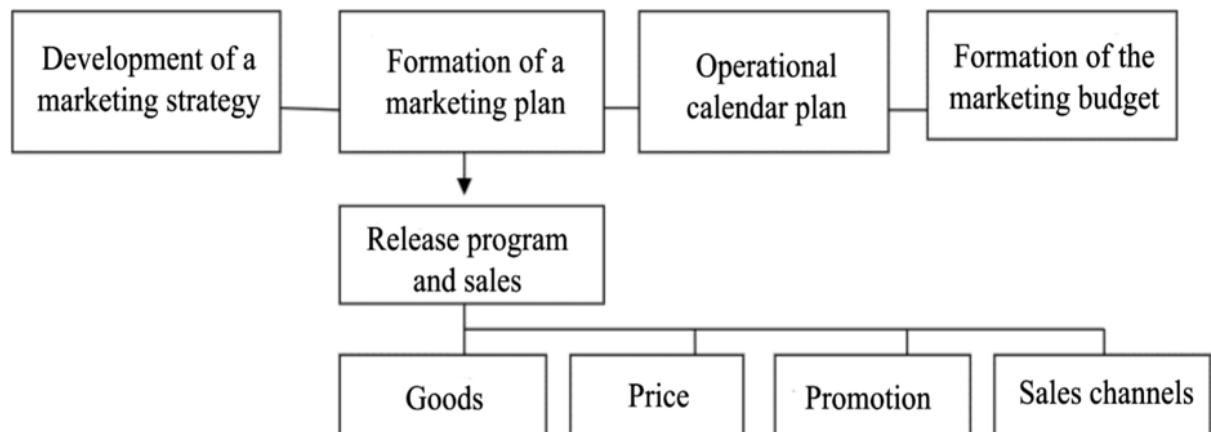


Fig. 2.6. General scheme of marketing planning

The marketing plan involves the development of action plans for each unit of the educational institution to implement the project. Such an operational-calendar plan essentially answers the question: who, when, where, what, at the expense of what resources and how should carry out specific measures of a production, technical and organizational nature. Accordingly, the amount of work at this stage of pre-investment studies also determines the amount of the budget. The most important part of this plan is the determination of the volume of production and sales within the framework of the projected market capacity. The final criterion evaluation of any such plan depends on the probable sales volumes of the products, therefore forecasting the market capacity and sales volumes plays a central role in marketing and is a decisive factor in planning production and part of investment costs, planning capacity loading, etc.

That is, the marketing plan in its formulation forms the basis for further financial calculations and the design of reporting forms accepted in international practice, which will be considered in subsequent sections.

The formation of a complex of consumer properties and benefits of the product in the project depends on the adopted marketing strategy, conditions of competition, organizational, technical capabilities and other factors. For this reason, product development should be carried out jointly by marketing specialists and participants in the educational process.

The planning of the educational project release program at each stage of the life cycle is carried out by various methods.

The consumption level method is harmoniously suitable for forecasting the demand for a joint educational program.

This method allows you to calculate the level of consumption based on standard, strictly defined coefficients. The main factor that determines the level of consumption is the level of income, which affects, along with other factors, how much money a consumer is willing to spend on the purchase of certain goods. The level of income is the main indicator of the level of consumption for a number of goods, and, with some exceptions, there is a high positive correlation between the amount of consumption of most goods and the level of income of consumers. However, the level of correlation is significantly different for different products.

Income elasticity of demand shows the extent to which changes in demand respond to changes in the level of income of the population. The value of income elasticity can be different not only for different products, but also for one product - for population groups with different wealth living in different regions. Therefore, where it is possible to calculate indicators of variation in the amount of income per capita within population groups with different incomes and in different regions, the analysis should not be reduced only to the indicator of the average level of income of a resident of this region, it should also include issues of the distribution of the indicator of income per capita within different professional, social, geographical groups.

Where there are small changes, it is quite possible to calculate and use the coefficient of elasticity for income per capita.

$$E = \frac{Q_2 - Q_1}{I_2 - I_1} * \frac{I_1 + I_2}{Q_2 + Q_1} \quad (2.6)$$

where E is the income elasticity of this product;

Q_1 - demand for goods in the base year,

Q_2 - demand in the next considered year,

I_1 - income per capita in the base year,

I_2 - income per capita in the next year.

A value of $E > 1$ implies product elasticity, $E < 1$ - no elasticity.

Price elasticity of demand.

Calculation of the price elasticity of demand complements the demand forecasting procedure. The price elasticity of demand is the ratio of the variation in quantity demanded to the variation in prices and is calculated as follows.

$$E_P = \frac{\frac{Q_1 - Q_0}{Q_1 + Q_0}}{\frac{P_0 - P_1}{P_0 + P_1}} = \frac{Q_1 - Q_0}{P_0 - P_1} * \frac{P_0 + P_1}{Q_1 + Q_0} \quad (2.7)$$

where E_p is price elasticity,

Q_1 - new demand,

Q_0 - existing demand at the current price,

P_1 - is the new price,

P_0 - is the current price.

The price elasticity coefficient is used to study the sensitivity of various project variables to price fluctuations. Fluctuations in the price level not only directly affect sales revenue, but have a significant impact on market size and, accordingly, on the level of production, which, in turn, affects production costs. However, when using the elasticity coefficient, it is assumed that other market conditions and market structure will remain unchanged. Moreover, the coefficient applies only to relatively small fluctuations in prices, since it cannot remain constant in the face of significant fluctuations in market prices.

Cross elasticity.

The demand for a particular product is determined not only by its price, but also by the prices of complementary goods and substitute goods. It is often necessary to determine the price fluctuations of which products affect the demand for the product for which the marketing analysis is conducted. This problem is solved by calculating the cross-elasticity of product A for product B according to the following formula:

$$E_{AB} = \frac{\frac{Q_{1A} - Q_{0B}}{Q_{2A} + Q_{1A}}}{\frac{P_{2B} - P_{1B}}{P_{2B} + P_{1B}}}$$

Thus, the cross-elasticity of E_{AB} is the ratio of the proportional change in demand for product A of the proportional change in the price of product B .

The value of E is interpreted as follows:

- If $E_{AB} > 0$, then product B can be a substitute for product A ;
- If $E_{AB} < 0$, then product B complements product A ;
- If $E_{AB} = 0$, then there is no cross elasticity between A and B .

The final use or consumption ratio method.

This method is particularly useful when considering the production of intermediate products. The essence of the method is as follows:

1. All possible options for using the product are determined, including its use in other industries, direct consumption, export and import.
2. Find or calculate "input-output" ratios in those industries that consume this product. In this case, it becomes possible to calculate the demand for the product for consumption, including exports and imports, based on the planned output volumes of industries that consume the product.

So, in order to forecast demand, for example, for methanol, a list of industries that consume it is first determined. These are industries that produce formaldehyde, fertilizers, as well as the pharmaceutical industry. Planned production levels in these industries reflect future methanol demand. At the same time, the needs of other buyers of this product based on their grouping are also taken into account.

A similar approach is used for some types of equipment, such as compressors and industrial turbines. The same approach can be applied to consumer goods and mixed product types. For example, the volume of cement consumption can be estimated by assessing demand from the private and public sectors of the economy, planned construction sites, etc.

This method uses consumption coefficients and is therefore sometimes called the consumption coefficient method. Having been estimated once, the consumption coefficient close to this element is multiplied by the scale of activity and we get an estimate of the future level of consumption.

Consumption rates vary over time, from market to market depending on the size of production units and as a function of changes in technology. When analyzing the demand for an intermediate product, the coefficients may vary depending on the size of consumer units, as well as changes in technology. So, for example, in the production of sheet steel, the need for steel can be significantly reduced if the thickness of the sheets is reduced to meet the new standards.

Because of the differences in the levels of consumption coefficients, special skills are required to predict their future values, despite the availability of accurate and reliable initial data.

This method of forecasting can be effectively used only when there are fairly accurate forecasts of expected changes in consumer industries. Such forecasts may be based on state plans for economic development.

Regression models.

When using regression analysis methods, the forecast is made on the basis of the equation of dependence between the predicted (dependent) variable and explanatory (independent) variables. Using the available input data, various combinations of independent variables are tested and this is repeated until an accurate predictive equation is obtained. At the same time, another problem may arise - how to get a forecast of independent variables.

Method of anticipatory indicator.

This method is a variant of the method of consumption coefficients and the regression method. A leading indicator is a variable that reacts to future changes in demand in advance and, therefore, can be used in forecasting. For example, research has found that changes in demand for electric fans outpace changes in the level of investment in residential construction by two years. To use a leading indicator in forecasting, you need to estimate the relationship between this indicator and the predicted variable.

This method eliminates the need to predict the independent variable, but it does not always allow to detect the leading indicator and, in addition, the time lag can also be unstable. The form of the relationship between the variables also changes over time.

For this reason, this method has very limited application, although it can be effectively used in some areas of the economy.

The specified methods are used in case of sufficient statistical data. In the absence of the necessary information, predictive calculations can be performed using methods based on various expert assessments. Among them, the following are the most common.

Survey of a group of managers of various services and departments of the enterprise.

In advance, these managers should receive relevant information on market analysis. In this case, the actual sales forecast represents something "average" from the views and intentions of the interviewed group of managers. This method of making a forecast is most suitable for new enterprises that do not have enough experience in using other methods. This method is also used when there are no detailed calculations on the state of the market, there are no complete statistics on sales trends of certain types of products.

Generalization of assessments of individual sales agents of the enterprise and managers of its sales divisions.

In this case, the market analysis is supplemented by the opinion of those who directly feel the reaction of consumers, who most acutely feel the slightest fluctuations in consumer preferences. The regional aspect is also taken into account: individual employees or sales managers can provide additional information about the specifics of the sale of certain products in different regions of the country. Accordingly, the accuracy of estimates with this method is higher than with the previous one. But the organization of such work requires large overhead costs (first of all, additional costs for the payment of specialists and analysts, data processing, etc.). Otherwise, the accuracy of the forecast may have a negative impact on the company's financial position.

Forecasting based on past turnover.

In this case, sales data for the past year are taken as a basis for predicting likely sales in the future. It is assumed that next year's turnover will exceed or be lower than the current year's turnover by a certain amount. Usually, a percentage increase relative

to the data of the previous year is taken according to the so-called principle "from what has been achieved":

This method of forecasting is suitable for industries and markets with a stable economic situation, an assortment of goods and services that changes rather weakly, where significant fluctuations in turnover occur extremely rarely. A typical example of such an industry is the utility industry. Using this method, it is impossible to take into account rapid changes in the nature of commercial activity, the structure of consumer demand, etc. As for competition, its degree is not taken into account here.

Analysis of trends and factors causing changes in sales volume.

The sales forecast is based on identifying probabilistic trends and statistically significant factors underlying them through market analysis. Usually, the following main factors are taken into account: long-term growth trends of the company, cyclical fluctuations in business activity, seasonal changes in the company's sales, technical changes, the appearance of new competitors on the market. This method is used more when making long-term forecasts. Statistical regularities discovered over many years, trends and dependencies neutralize the effect of random and secondary factors. However, with the help of this method, it is difficult to forecast for a period of less than 3-5 years, since the sample, the array of processed statistical information, and the period of manifestation of cyclical fluctuations are too small. This method is most suitable in capital-intensive industries.

Forecasting based on the "market share" of the firm's sales, in which the turnover is forecasted as a certain percentage of the firm's market share in the given industry, i.e., sales for the entire industry are first forecast, and then the company's share in the total sales of the entire industry is calculated. When using this method, it is important, firstly, to be sure of the accuracy of the forecast for the entire industry, and secondly, not to take into account non-price competition in it (at the level of new products and services).

End-use analysis.

The forecast is based on the expected volumes of orders from the company's main customers (turnover usually exceeds this indicator by a certain, predetermined

percentage). The application of this method requires conducting special studies on the main industries that consume the products of this enterprise, collecting and processing significant statistical and factual material. It is mostly used in the fields of raw materials and energy complexes, as well as at enterprises that produce component products and assemblies.

Analysis of the assortment of goods, in which sales forecasts for individual types of products are combined and form the planned turnover of the enterprise.

This method is most suitable for highly diversified firms, but the accuracy of the general forecast depends entirely on a detailed market survey of each type of product, which in turn requires significant costs.

Trial marketing.

Considered to be the most accurate approach to sales forecasting, in which the new product or any changes made to the system of promoting products in the market are carried out in a very small market (for example, within a few cities). In essence, an attempt is made in a small local market to model everything that will then be done on a national or larger regional scale. The components of the future promotion program of a new product on the market (prices and types of advertising, sales channels and type of packaging, etc.) are tested on a limited group of consumers. After processing the received information about the volume and growth rate of sales of a new product, the relevant hints regarding the sales forecast are distributed throughout the country.

The standard probability distribution method is based on the PER (program evaluation-and-review) method, that is, the method of evaluating and reviewing plans using network models and methods of planning and management.

The essence of this sales forecasting method is as follows. Three types of sales forecasts are determined by experts: O - an optimistic forecast, M - the most likely forecast and P - a pessimistic assessment of the sales forecast. Next, the expected value of the sales forecast (ER) is calculated according to the standard formula:

$$E_P = \frac{(Q + 4M + P)}{6} \quad (2.9)$$

Using this method allows you to compare expert estimates with the statistically expected value to determine the most likely range of variation in the sales forecast.

2.4 Using the principles and approaches of flexible methodology (Agile) in planning and implementing the educational process

The use of principles and approaches of flexible methodology (Agile) is increasingly finding a place in the planning and implementation of the educational process. A number of Chinese universities, institutes and colleges are no exception.

Preparation of curricula for joint international educational programs using Agile tools and technologies takes place. In particular, at the Yanchen Polytechnic Institute for the preparation and implementation of a joint educational project for the preparation of bachelors with the Black Sea National University named after Peter Mohyla called "3+1".

The purpose of this project is to integrate the efforts of Chinese and Ukrainian partners to achieve a synergistic effect of the quality of educational services provided to Chinese citizens.

For the first three years, students study at the Yanchen Polytechnic College, after which the fourth year of study takes place in Ukraine, on the territory of the Black Sea National University named after Petro Mohyla. The distribution of 100% of the load on the teachers of the Ukrainian partner takes place according to the formula of 10% of the total volume for the first three years of study, and 70% for the fourth year (Figure 2.7).

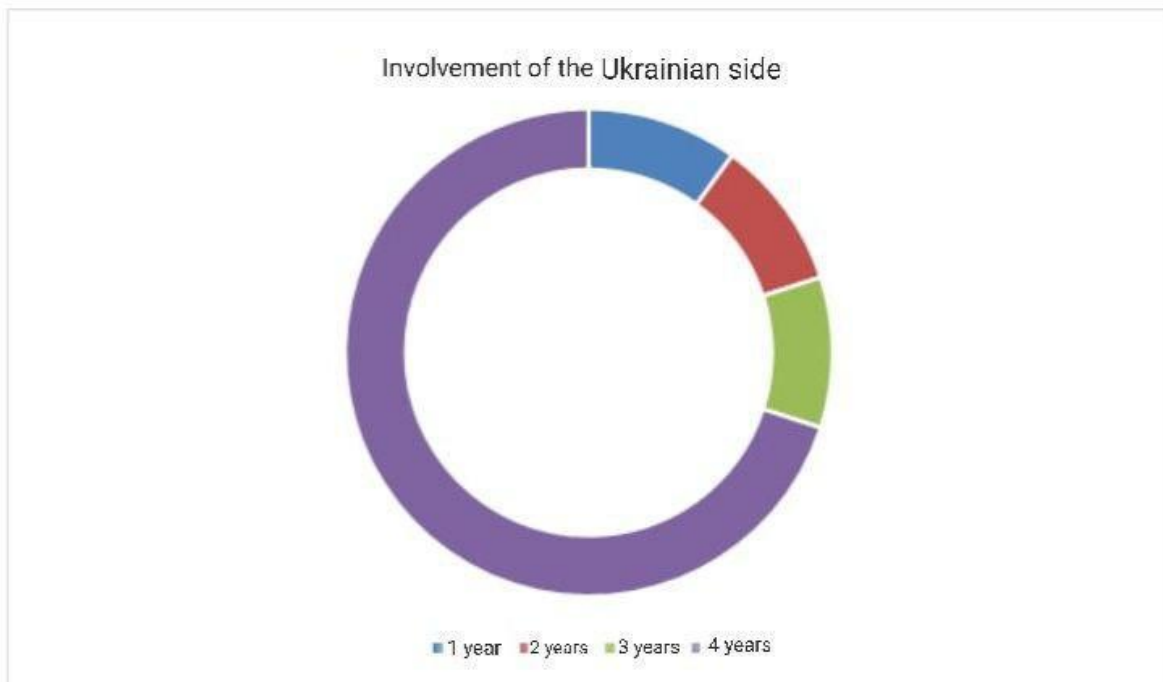


Fig. 2.7. Ring diagram of the involvement of Ukrainian teachers in the implementation of the "3+1" specialized bachelor's training program

The preparation of training materials is divided into sprints, with further improvement throughout the duration of the program implementation. The main "customer" in this program is the student, and the ultimate goal of each project within the program is the student's competence in the labor market after receiving a diploma. Therefore, this program can be considered complex, and one that is constantly dynamically evolving, as the needs of the Chinese labor market are constantly changing and developing.

When planning the educational process, it is increasingly possible to use the principles of the Agile methodology [23]. Institutions of higher education implementing a joint international specialist training program are no exception. This is how the preparation of a joint educational project between the Black Sea National University named after Petro Mohyla and the Yanchen Polytechnic Institute called "3+1" is underway.

The planning of this program takes place with the help of Agile approaches, namely with the use of the Kanban methodology. In this case, KanbanFlow software is used.

KanbanFlow is an online tool for both individual and collaborative work on "lean development" projects with the Kanban methodology [24]. The service allows you to add several kanban boards for planning and tracking work on various projects.

The service is suitable both for increasing personal productivity and for project and team management.

As soon as any team member makes a change to the board, those changes are reflected on all team screens. So if you add, remove or move a task to yourself, the same action will be repeated for the rest of the team.

If desired, you can monitor the time spent on the task using a timer. The timer supports the popular Pomodoro method for time management.

Key features of KanbanFlow:

Visualization of work.

Task numbering.

Collaborate in real time.

Subtasks to track progress.

Integration with other systems.

Revision of changes.

Time tracking with Pomodoro support.

People and roles.

Documents and file attachments, including from Dropbox and Google Drive.

Export and import data in Excel, CSV, XML and JSON.

Analysis and development of the process.

Support for mobile devices.

Copying boards.

Analysis and improvement of the work process.

Adding tasks from email.

Appointment.

Filters and search.

Figures 2.8 - 2.10 present the board of tasks and subtasks of the specialized bachelor's training program "3+1" in KanbanFlow.

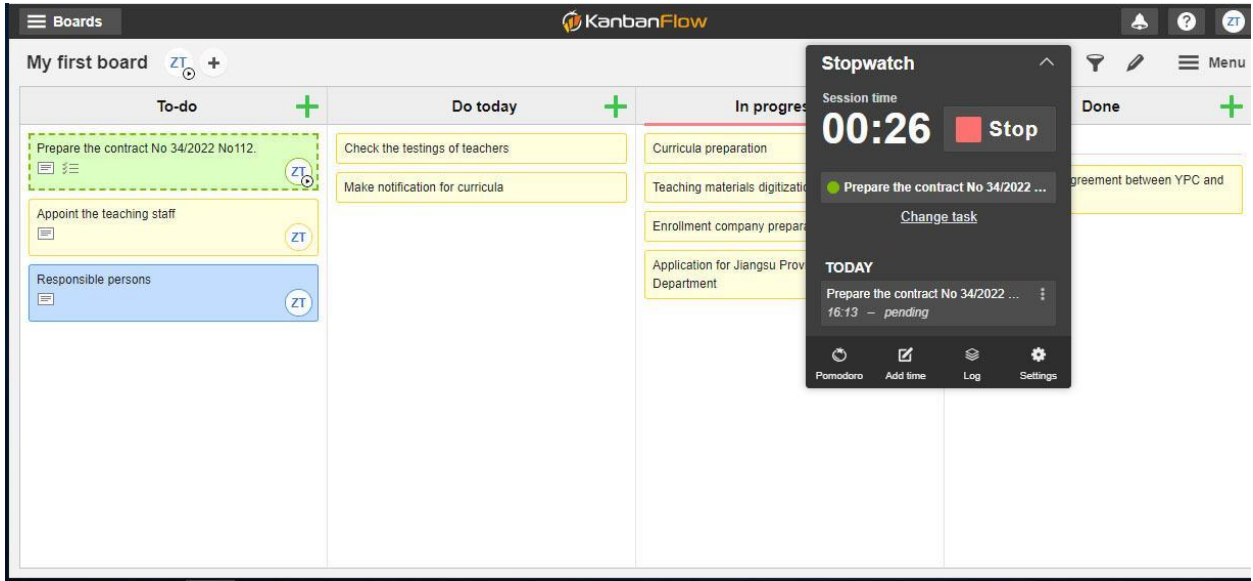


Figure 2.8. Task board of the "3+1" specialized bachelor's training program in KanbanFlow

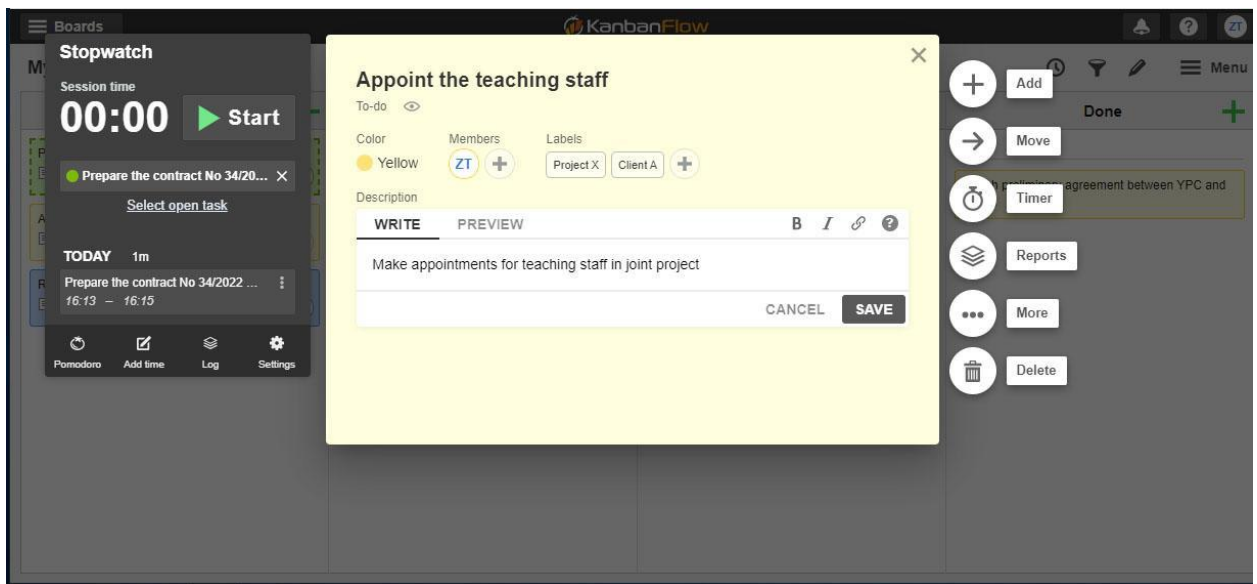


Figure 2.9. Task assignment menu of the "3+1" specialized bachelor's training program in KanbanFlow

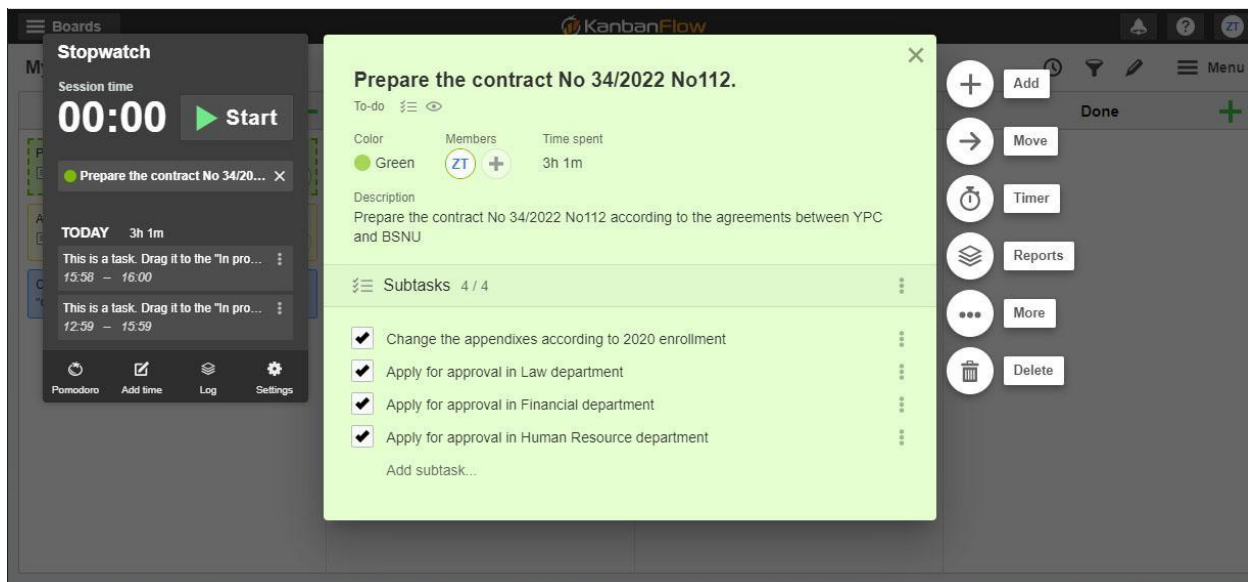


Figure 2.10. The menu for assigning subtasks of the "3+1" specialized bachelor's training program in KanbanFlow

The use of modern software accelerates the processes of managing a complex project of a specialized "3+1" bachelor's training program. The Agile approach has proven itself very successfully - the distribution of tasks into sprints, the construction of a Kanban board and the involvement of the student as a "customer". The KanbanFlow online tool has never been used for this task before. Its use reduced the time spent on project management and improved the interaction of the international team, which consists of Ukrainian and Chinese specialists.

The preparation of training materials is divided into sprints, with further improvement throughout the duration of the program implementation. The main "customer" in this program is the student, and the ultimate goal of each project within the program is the student's competence in the labor market after receiving a diploma. Therefore, this program can be considered complex, and one that is constantly dynamically evolving, as the needs of the Chinese labor market are constantly changing and developing.

Conclusions to chapter 2

The broad possibilities of using ICT in the Agile digital environment for structuring the goals of tasks, milestones and stages of international projects are

substantiated. The Agile platform is based on direct communication between IECP-PAM subjects in a special bullpen office, which allows for successful interaction between institutional subjects of the project (from different universities), performing subjects, managers and clients. The strategy of such an office is to use the Agile methodology to structure the overall cycle into mini-cycles of local software products. Local and integrated software products in the Agile environment act as a digital analogue of the project's technical documentation.

The basic principles for the primary organization of decisions on coordinating the environment and activities of participants in international projects using ICT & Agile are defined. The priority principles are: the primacy of the general vision of the content and target direction of the IECP-PAM type project; a clear understanding of the communication regulations between project subjects, the flow of resources in the middle of the project's operational system; ensuring successful prioritization of the task list; achieving a rational compromise between the complexity of the development and the "value of the user story"; improving the quality and reducing the duration of feedback.

In order to direct the successful direction of the Agile methodology to the implementation of the tasks of the IECP-PAM cycle, the studied Agile Modeling, Agile Data Method, DSDM, Essential Unified Process were combined with the following methodical components: function-oriented development (FDD), an iterative approach without functional specifications , (Getting Real), Scrum rules for managing development and coding processes, Software Development approaches, methodological components of educational management and marketing, conceptual foundations of convergence theory, stakeholder theory, and project core values. This methodical foundation of the research ensures success: the use of Agile methodology in the preparation and implementation of the IECP-PAM cycle; communications of international project participants; creativity and innovative thinking of the project manager and executors. The specified components of the methodological basis allow to form a convenient information model for managing the IECP-PAM cycle through dynamically connected models of micro-cycles, and further to form the resulting

software product for managing the content and values of the international educational process.

CHAPTER 3. FORMALIZED MODELS OF EFFECTIVE MANAGEMENT OF INTERNATIONAL EDUCATIONAL SCIENTIFIC PROJECTS

3.1. The technology for determining the applicability of the principles and approaches of the flexible Agile methodology in an educational institution

During its existence, the Agile methodology has become a standard tool for software development management. Software development companies have contributed to the infiltration of Agile ideas into university education programs that train project management managers, programmers and web designers. Agile methodology is already used not only in the IT industry, but also in the banking sector, in state management, as well as in various areas of business [30, 31].

Therefore, the use of Agile in the management of educational projects is a rather promising direction, to begin with as an alternative or complementary methodology, and even now Agile is partially used in the educational field [34, 35]. The main reasons for the slow implementation of the Agile methodology in the educational activities of higher education institutions are bureaucratization and obsolescence of organizational forms of education. The direction of more promising application of Agile methodology in Ukrainian universities is international educational projects with scientific communities and foreign universities, because the latter have rich experience in applying flexible methodology. The analysis of the values of the Agile Manifesto carried out in the previous sections of the work proves that the application of Agile principles is not limited to the field of software product development, Agile values are also used in other areas, such as public administration, economy, science, education. Therefore, the application of Agile methodology and its values in educational institutions, namely in international educational projects, will allow better preparation of students for the current requirements of employers and will facilitate work in conditions of international differences.

In this study, an analysis of Ukrainian universities that tried to implement Agile

methodology in the educational process was carried out. Expanded purposive sampling proved to be relevant for the study because the respondents practice Agile methodology in their educational organizations. The questionnaire data and the results of the conducted interviews, divided by educational institutions, are summarized below.

In the first studied university (hereinafter, University A), the Scram methodology was applied, which proved itself well in distance work, students quickly and enthusiastically mastered it, and began to actively use it. A Scram structure consisting of 9 teams was created, the Scrum-master was selected from the students using a special method). Teachers acted as Scrum masters, experts who chose 3 teams.

At the beginning of work in cases, 54 students started. Two areas were formed, three cases of tasks for the creation of a meaningful product, which should be the result of working out the case. One case was related to the chemical processing of plastic, the other two are related to the circular economy, that is, when the collection of plastic waste is set up, and then this waste is recycled back into plastic, and this plastic is put back into the economy. The case is interesting in that students from different departments, who are used to working only in their subject area, worked on a characteristic task of the chemistry faculty. Students gained experience working on a task that connects all areas of chemical technology between themselves and the economy, so for students of the chemical direction, it turned out to be a serious immersion in the market economy. The uniqueness of this project is that it took place completely online.

Professional
competences



Case №1

Chemical processing of plastic as a way to transition to a circular economy



Case №2

Development of separate waste collection of containers and packaging made of PET and polyolefins



Case №3

Ecosystem the market secondary plastic



Team №2

The project "Chemical processing and alternative solutions for the disposal of a mixture of plastics"



Team №4

The project "Second life of used PET"



Team №8.

Project "Chemical recycling as an alternative to incineration of plastic waste"



Team №1

"Second life of plastic" project"



Team №5

"Ecorycycling" project



Team №9

Project "Ecological social network (in schools)"



Team №3

New services and functions for the digital trading platform for secondary raw materials



Team №6

Development of the digital platform concept



Team №7

Trading platform as a tool for optimizing the secondary plastic market

Fig. 3. 1. Case topics of the university under study
The uniqueness of this project is that it took place completely online

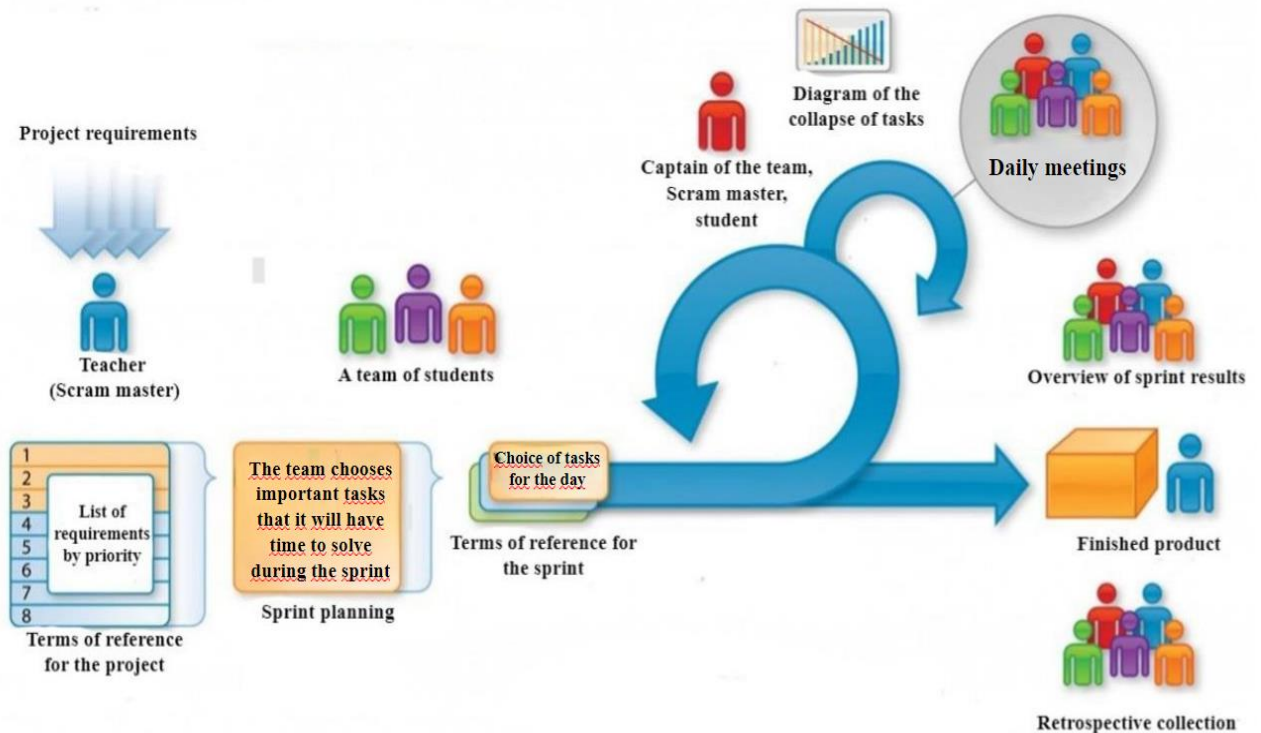


Fig. 3.2. Planning the Scrum work of the university team

In the second researched university (hereinafter, university B), during the training of IT specialists within the framework of software project management disciplines, the study of existing project management approaches, including Agile methodologies, is provided, based on the world experience of using the Scrum methodology in the educational process. An example is the Dutch eduScrum project, which teaches teachers to use Scrum in the classroom. The experience of the eduScrum project proves that working in a Scrum team increases the motivation of schoolchildren and allows them to achieve higher learning results. At University B, the Scrum methodology was used in the study of the topic "Preliminary assessment of the labor intensity of a software project."



Purchased by a student competencies

Planning, readiness for new things, flexibility, organization of processes, experience, experimentation, technical competence, systematization of information, research activity, presentation



Team competencies

Responsibility for the result, non-standard thinking, critical thinking, teamwork, practical use of knowledge, creativity, inclusion in the process, communication

General culture	General professional	Professional
Ability to abstract thinking, analysis, synthesis; Willingness to act in non-standard situations, bear social and ethical responsibility for the decisions made; Readiness for self-development, self-realization, use of creative potential.	Readiness for communication in written and oral form to solve problems of professional activity; Willingness to manage a team in the field of professional activity, tolerantly perceiving social, ethical and cultural differences.	Correspond to the types of professional activity on which the master's program is oriented Professional competences through participation in the development of case ideas

Fig. 3.3. Acquisition of professional competences through participation in cases

It is important to note that the students, previously the students were already familiar with the rules of writing technical specifications, have the basics of the UML language, the basics of designing a software product, and have a tool for identifying risks in an IT project. All this knowledge is involved in the students' work on the project.

The teacher plays the role of the owner of the future product, and forms the Product backlog. Students already possess one of the programming languages at a sufficient level and perform the roles of IT product developers. They receive the task of creating a software product that will allow automating the estimation of the labor intensity of the future software project. For this, students are divided into teams of 5-9 people. Each team is given the task of creating a software product, while the implementation of the program is different for each team (mobile application, desktop application, web application). Before starting work, each team creates a Scrum board (the Trello project management system is used). One sprint lasts 1 week. Students are

assigned 4 lessons to develop the final product. At the beginning of each class, a stand-up meeting is held, where a representative from each team speaks (to save time). Each last lesson of the week ends with a check of sprint tasks, after the check, students mark the results of their work on the Scrum board. After completing all the tasks of the product backlog, the students present their work results and demonstrate their developed product to the team.

The main advantages of using the Scrum methodology in the process of teaching professional disciplines are that students are trained in conditions similar to real projects, which allows them to develop teamwork skills using Agile methodologies. This approach to education contributes to increasing personal professionalism and mastering the skills of planning personal activities, and contributes to the acquisition of initial project management skills.

Therefore, the application of the Scrum methodology in educational institutions, namely in the process of studying professional disciplines for the specialty of software engineers, significantly reduces the gap between the level of academic training and practical requirements for an IT specialist.

So, the essence of flexible Agile training and scientific approaches to its application in the training of future chemists and software engineers have been considered. In order to obtain reliable data when assessing the level of implementation of the Agile methodology in an educational institution, the author developed a questionnaire. In the process of creating the questionnaire, the main issues were raised. The intention is to obtain transparent data for further research within this work. The questionnaire is divided into three types: for teachers who play the role of leading expert managers, Scrum masters; student team captains acting as Scrum masters; for students who are members of the Scrum team. The questionnaire for the teacher consists of 8 questions, for captains of the Scrum master team - 9, and for team members - 8 questions. Multiple choice questions were provided for better understanding of the respondents. The results of the survey of university teachers 1 and 2. The results of the survey are shown in Table 3.1.

Table 3.1 Questionnaire data of teachers

№	Questions for teachers (managers)	University 1	University 2
1	Your position in the project	Manager	Customer
2	Work experience in this position	3 years	5 years
3	Your education	Higher, d.t.s.	Associate professor, c.t.s.
4	How many teams do you lead?	3	8
5	Do you have experience with Scrum? If there is, which one?	Yes, 2 years	Yes, 3 years
6	Is Scrum standard in an educational institution? (Yes No)	No	Yes
7	Is Scrum the most common agile method in your educational institution?	Yes	No
8	What flexible methods do you use in your educational institution?	-	Kanban is used more often, which provides the possibility of daily reorientation of tasks. This is necessary when integrating systems. If such a task is not set, Scrum is used.

The results of the survey of student team leaders and Scrum Masters. The results of the survey are shown in Table 3.2 by the teams of Universities A and B.

Table 3.2. Profile data of Scrum masters

№	Questions for students of team leaders - Scrum masters	University 1	University 2
1	Your position in the team		Scrum master
2	Work experience in this position	2 years	0
3	What is your	bachelor (future	Junior bachelor

	education?	chemical engineer)	(future software engineer)
4	Have you been trained as a Scrum Master?	No one-week course at this educational institution, independent study	No one-week course at this educational institution, independent study
5	How many Scrum teams have you managed?	2	0
6	What roles in the Scrum team have you had before?	Scrum master	Developer
7	Are you using pure Scrum or Hybrid Scrum?	Scrum hybrid	Scrum hybrid
8	What agile method do you use with Scrum?	Agile methods	Kanban
9	What Scrum events do you use?	Sprint Retrospective, Backlog, Grooming, Sprint Review	Sprint, daily meetings, retrospective

Sprint, daily meetings, retrospective

The results of the survey of the members of the development team The results of the survey are shown in table 3.3 for the teams of University 1 and University 2.

Table 3.3. Profile data of members of the development team

№	Questions for students of team leaders - Scrum masters	University 1	University 2
1	Your position in the team	Chemist engineer on technological processes	Software developer
2	Work experience in this position	2 years	3 years
3	What is your education?	bachelor (future chemical engineer)	Junior bachelor (future software engineer)
4	Do you have experience working in a Scrum team?	Yes	Yes
5	How long have you been working with Agile Scrum?	2	3

6	What Scrum Team roles have you had before?	Developer, Scrum master	Developer
7	What agile method do you use with Scrum?	Agile methods	Kanban
8	Which flexible method suits you best?	Scrum, a hybrid method	Kanban, a hybrid method

The extended purposive sample proved to be suitable and relevant for the study, as the respondents practice the Scrum methodology in their educational institutions. Below is an overview of the data collected based on questionnaire data and interviews with faculty managers, student Scrum Masters, and student team members. The generalized result for the two educational institutions is shown below in the form of segmented data. The studied Scrum teams have differences and common features. Tables 3.4-3.6, presented below, reflect the presence or absence of certain elements of Scrum in terms of teams.

Table 3.4. Availability of Scrum roles by teams

Scrum roles	University team 1	University team 2
Scrum master	+	+
Product Owner	-	+
Development team	+	+

The generalized result shows that a certain regularity can be observed in the studied teams. As part of this research work, cases were identified indicating that the team was not using the full potential of Scrum. The lack of knowledge and experience in Scrum was the result of not completing all of the Scrum activities. Instead, it was observed that the University 2 team has its own Scrum standard. This standard was adapted to the needs of the research team.

Table 3.5. Availability of Scrum artifacts by teams

Scrum artifacts	University team 1	University team 2

Sprint backlog	-	+
Product backlog	+	+
Product increment	-	+
Scrum standard	-	+

Table 3.6. Availability of Scrum roles by teams

Scrum artifacts	University team 1	University team 2
Daily meetings	+	+
Sprint planning	+	+
Backlog update	-	+
Sprint overview	-	+
Sprint Retrospective	+	+
Sprint duration (weeks)	2	1

Teams in their work combined Scrum with Kanban in ScrumBan. The reason was that Kanban was more flexible than Scrum. For example, Scrum did not allow fixing bugs found by testers at the end of the Sprint that needed to be fixed. According to Scrum rules, these bugs can only be fixed in the next Sprint. However, according to Kanban, there is no such limitation.

Data analysis of the Scrum method within educational institutions.

The results of the questionnaire and interviews showed that University A does not follow the definition of Scrum as defined by the authors of Scrum. The interview pointed to the fact that the company had its own view on Scrum, depending on the specifics of the executed projects and the composition of the teams, the Scrum method is adapted to the required template. The team didn't stick to using Sprints, instead calling them their Pulses. Pulse was similar to Sprint and Sprint Review, which is done once in each Sprint. Instead, University A had several Sprint Reviews. Once a week and at the end of Pulse. In pure Scrum, it is accepted that the product should be presented after each sprint, and not every week. The company had weekly reviews of Pulse because the project was complex. There was a need for weekly meetings to discuss details. The length of the Pulses may vary depending on the workload and the addition of new tasks. If we equate Pulses with Scrum Sprints, the length of the Pulse is an anti-pattern. Changing the length of a sprint can lead to product quality

degradation. There were no daily meetings or retrospectives in the University A team because it was thought that this event was redundant, so the team worked online and could always discuss issues very quickly in a working order in online chat. Still, meetings were held once a week, and the format of the meetings was similar to daily meetings. The absence of daily meetings in the University A team is an anti-pattern of Scrum. Members of the development team were assigned tasks from the top. The anti-pattern is that the development team faced a task that had already been evaluated for them, and the Scrum team needed to evaluate the task independently.

There were 6 people in the team. According to Scrum requirements, a team should consist of three to nine people to be as productive as possible. The Product Owner role was absent from University A's teams. This role was covered by the Scrum Master. This is a big departure from Scrum principles. The Scrum Master role should not be combined with another role. This can lead to confusion within the Scrum team and lead to the wrong path. Conclusion for University A, they do not follow Scrum as it is defined by the authors of the method. They took parts of Scrum and adapted them to their needs. Depending on the stage of the project, they follow Scrum and Kanban depending on where it is convenient. It is customary to combine Scrum and Kanban with each other, as it is implemented at University A. The Kanban method can be better than the Scrum method from the point of view of project schedule management. With Kanban, it is possible to be more efficient in terms of reducing project implementation deadlines, which is confirmed in the case of the University A teams.

Currently, we will analyze the teams of the University of St. All the company's respondents indicated a lack of staff. Because there was a shortage of staff, some roles were combined. In such a limited composition, the team felt overloaded, it was difficult to follow the Scrum methodology. Scrum events did not bring a sense of benefit because the events were too time-consuming for a small group of people. Missing roles also affected Scrum artifacts. The Product Owner shall be responsible for the Product Backlog. The backlog was not properly maintained, as the Product Owner function was performed by a teacher, for 8 part-time teams at once. Web designers at the company had a lot of work. In addition to how to develop software, they also had to perform

software testing. Independent testing helps avoid author bias and is often more effective in finding and detecting errors and defects than self-testing or group testing. This type of testing is generally performed by individuals not directly related to the project or by representatives of other organizations hired primarily to verify the quality and performance of the developed product.

Developers can also participate in testing, especially at low levels, but a lack of objectivity often limits their effectiveness. Independent testers may have the right to define testing rules and processes. Conducting testing not by individual testers, but by the developers themselves in the University team is a deviation from the Scrum method. In the team of University B, there was a lack of roles defined by Scrum. They only had daily meetings and sprint reviews. Other events were not held, so the team lacked knowledge about the Scrum method. The authors of the Scrum methodology say that the Scrum master should explain the rules and values of Scrum to the team members, but this was not provided by the Scrum master. The University B team also deviated from the Scrum method defined by the authors of the method. Although the team completed all Scrum events, they occurred with some inconsistencies. Up to one hour of time was spent on daily meetings. Moreover, the issues discussed there were not always relevant for all present members of the Scrum team. Although some roles in development teams are combined in the University team, this does not mean that members of the development team are multifunctional. The data collected during the interviews showed that some team members did not have the competence to work in other roles. Harmful practices used in Scrum teams will eventually harm the project and the team in the long run.

A team manager at University A reported that the school did not have a Scrum Standard. The team itself decided how it was convenient for them to work. The Scrum method was adapted to teamwork. The team used some elements of Scrum. For example, their version of Sprint was called Pulses. It was clear that Scrum cannot be directly implemented as described by its authors. Scrum could not be implemented in the University A team for reasons. Because each team had its own standard. The faculty product owner in University B's teams said that they had a Scrum standard. But the

team still did not always follow the rules of Scrum. In other words, it was a ScrumBut. All Scrum Masters reported that teams did not follow Scrum requirements. The questionnaire data showed that the teams did not follow the same way of working. This may mean that the teams, and therefore the institution, have multiple ways of working. The development team followed Scrum as much as their resources allowed. The conducted research showed that one of the reasons for the difficulty of adapting flexible methodologies in educational institutions is people. In particular, lack of knowledge about the methodology, lack of experience with Scrum, low level of adaptation of training staff to innovations, location, lack of training. The results of the interview demonstrated the absence of all Scrum roles defined by the method.

One of the main factors that could be seen in both Universities, one of the reasons why the teams were not able to follow Scrum, was that they were understaffed. Because they were understaffed, the teams did not have all the roles or complete all the Scrum events. To compensate for missing roles, team members had to combine their roles with other roles. The absence of Scrum events has led to deviations, which in turn means that teams will work with ScrumBut. However, one can also object and suggest that Scrum is a flexible methodology and is designed for change. Nevertheless, this kind of deviation cannot fit the Scrum definition defined by the authors of the method. As part of this research work, cases were identified indicating that the team was not using the full potential of Scrum. The lack of knowledge and experience in Scrum was the result of not having completed all of the Scrum activities. Deviation was noticed during questionnaires and interviews. Namely, the team has its own Scrum standard. This standard was adapted to the needs of the studied teams. Teams in their work combined Scrum with Kanban in ScrumBan. The reason was that Kanban was more flexible than Scrum. For example, Scrum did not allow fixing bugs found by testers at the end of the Sprint that needed to be fixed. According to Scrum rules, these bugs can only be fixed in the next Sprint. However, according to Kanban, there is no such limitation. One of the main requirements of Scrum is the presence of a cross-functional team. The conducted interview demonstrated that the team of University B consists of a group of students of the same specialty and cannot be cross-functional. During the

Sprint, team members tried to choose jobs and tasks from the backlog according to their competence and experience. Different researchers define and describe this antipattern as semi-functional teams. For this reason, universities need to look for people with the necessary competence outside the team, possibly from other departments or faculties, as was done in the teams of the University of O. In other words, when tasks arise that cannot be solved by the Scrum team, they require the transfer of such work to external experts to outsourcing. Table 3.7 below presents the most common common factors between teams identified by the author in this study.

Table 3.7. Summary of common factors

No	General factors	Effects
1	Lack of staff	Roles are merged and Scrum events are not used to their full potential
2	Undefined roles	Misunderstanding of who does what
3	Do not get knowledge about the Scrum method	Scrum events and roles are not executed
4	Bugs at the end of the sprint	Scrum combines with Kanban to eliminate sudden errors.
5	Semi-functional commands	Tasks are solved by experts outside the Scrum team.

According to the conducted research, it can be assumed that both researched educational institutions follow the definition of Scrum. University A took parts of Scrum and adapted them to their needs. Depending on the stage of the project, they follow Scrum and Kanban depending on where it is convenient, while at University U, even though the team did all the Scrum events, they happened with some inconsistencies. Up to one hour of time was spent on daily meetings. Moreover, the issues discussed there were not always relevant for all present members of the Scrum team. Even the fact that the roles in the development teams of the University are combined, it does not mean that the members of the development team are multifunctional. The data collected during the interviews showed that some team members did not have the competence to work in other roles. It was not possible to clarify to what extent the teams follow the company's Scrum standard, considering the fact that both managers of University. A reported that their organization does not have

a Scrum standard. The studied educational institutions followed their version of Scrum work, and they did not always follow the rules defined by the Agile methodology. In other words, both companies use ScrumBut to one degree or another. The analysis of the data made it possible to determine five main common factors in Scrum teams, which are the reason for making adjustments to the Scrum framework. These include - lack of personnel, undefined roles, lack of knowledge about the Scrum method, errors at the end of the sprint requiring the combination of Scrum with Kanban, semi-functional teams.

3.2. Benchmarking model of an educational institution

In the modern conditions of development of IT technologies, competition among educational institutions is also increasing, therefore the use of benchmarking becomes not only necessary in the field of education, but also mandatory if the university wants to survive. Every year, with the development of Internet technologies, consumers of education reveal higher standards and requirements for the education system. In this situation, educational institutions must carefully choose and apply methods of improving their activities, taking into account new approaches, focusing on the best. In the era of the information society, knowledge is rapidly changing and spreading, preventing educational institutions from being successful without a real competitive advantage. There are numerous providers of scientific and educational services in the form of new educational institutions, corporate universities, Internet providers that use advanced learning technologies, customers who entice and crowd out educational institutions on the market.

An undoubted argument in favor of the benchmarking methodology is that it is easier and cheaper to adapt someone's tested ideas than to develop them yourself and learn from your own mistakes. Leaders of educational institutions can use benchmarking not only to improve processes, but also as a tool for strategic planning and forecasting, as it deals with the study and analysis of the environment, surroundings, trends, and the search for goals and landmarks. A lot of literature is

devoted to the methodology of benchmarking in general and in the education system, in particular.

N. V. Navolska notes that benchmarking is a process of constant comparison of the methods and results of the organization's work, its individual divisions, functions, processes with organizations chosen for imitation [36]. Benchmarking is a repeated action, it should be carried out continuously, be formally fixed in the organization and be part of the general process of improving the activity. In [37], attention is directed to the creative nature of benchmarking and its orientation to the best existing practices not only of similar organizations, but also of companies from a non-competitive environment. According to the authors, it is also necessary to analyze, along with the main indicators, functions, processes, strategies, which will allow them to reach the level of competitors, and even surpass it.

L.M. Gerasimchuk, L.S. Pankovska [38] pays attention to the study of forms and methods of identifying reference enterprises that have achieved significant success in various functional areas, ways of their adaptation to the conditions of their own organization. At the same time, the authors highlight the active interaction and cooperation of partners who exchange information for the purpose of a mutually beneficial partnership to improve individual processes and increase the competitiveness of the organization as a whole as a key condition for the effective implementation of benchmarking. Forms of such interaction can be formalized and informal. Formalized forms include:

- 1) partner benchmarking;
- 2) corporate benchmarking;
- 3) regional benchmarking;
- 4) institutional benchmarking;
- 5) interactive benchmarking.

Non-formalized include all possible forms of personal communication between managers and employees both with colleagues from their organization and with representatives of competing companies.

Yaremenko L.M., Ponomarenko Ya.A. the concept of benchmarking means the

implementation of advanced and better management methods in the company's activities, which were identified in the process of researching other companies successfully operating in the same industry [39]. Benchmarking combines the search, research, application and adaptation of the experience of enterprises of any industry with the aim of forming effective financial management. Okhrimenko G.V. defines the concept of benchmarking as a method of increasing the competitiveness of educational institutions. The following criteria for evaluating an educational institution are proposed, such as: availability of the latest teaching methods in an educational institution; involvement of foreign teachers, partners and teachers of other institutions in cooperation; implementation of the latest methods of attracting applicants. Based on the results of an empirical study, the status and prospects of the use of benchmarking in the implementation of educational services by leading classical universities of Ukraine were determined [40].

A wide range of theoretical approaches to the use of benchmarking in education does not provide a reliable solution to the leading problem - the choice of a partner by an educational institution for international joint educational projects. This prompts the development of a method of partner benchmarking for educational institutions.

The decision to conduct international joint educational projects belongs to the category of strategic management decisions of the top management of the educational institution. Such a decision can fundamentally change the entire strategy of activity, therefore, to begin with, it is necessary to conduct an in-depth analysis of the competitive environment and carefully study potential foreign partners. At the same time, it is necessary to assess one's own potential for international cooperation and establish what resources are necessary for entering into cooperation, whether one's own resources are sufficient, or whether they need to be filled at the expense of partners. The same should be done regarding the abilities, competencies and level of the management methodology of the educational institution.

The study of the competitive environment should begin with the study of the experience of leading educational institutions, using the long-known benchmarking toolkit, which is not so widely used in education. Honcharuk A.H. notes that

benchmarking is a technology of studying the experience of best practices in order to build some standard, with which reference comparison will be made in the future [41]. According to Donovan R.K. benchmarking is the process of identifying, studying and adapting the best practices and experiences of other organizations to improve the performance of one's own organization. [42] In contrast to industrial corporations, in the field of education benchmarking technology began to be used relatively recently, but every day this technology is introduced into the daily activities of educational institutions, which, when building their strategy, compare their indicators with the achievements of competitors, as well as correlate them with global ones indices.

In this study, we take an educational institution as the research organization. As was shown in [40], the main goal of benchmarking in relation to a reference educational institution is the calculation of reference indicators. The main target orientations in this case will be as follows (Fig. 3.4)

- analysis of own key indicators;
- detailed analysis of their problem areas and identification of gaps;
- search for educational market leaders for comparison;
- analysis of experience of best practices;
- building a sample for comparing key indicators;
- generation of improvement initiatives;
- implementation of the benchmarking project.

Another, no less important reason for using benchmarking in the activities of educational institutions is its investment focus. The direction of investment is determined after a benchmarking analysis. It is important to note that the benchmarking analysis process also requires spending not only financial, but also information and time resources, as well as professionally trained personnel. As a rule, the leaders of the educational services market have a trained team of marketing professionals who periodically conduct benchmarking analysis of their institution's activities in various fields. In such a case, partnership relations between institutions are a key factor, since a participant in the educational market will provide information to a competitor if business-friendly relations are not established between the organizations.

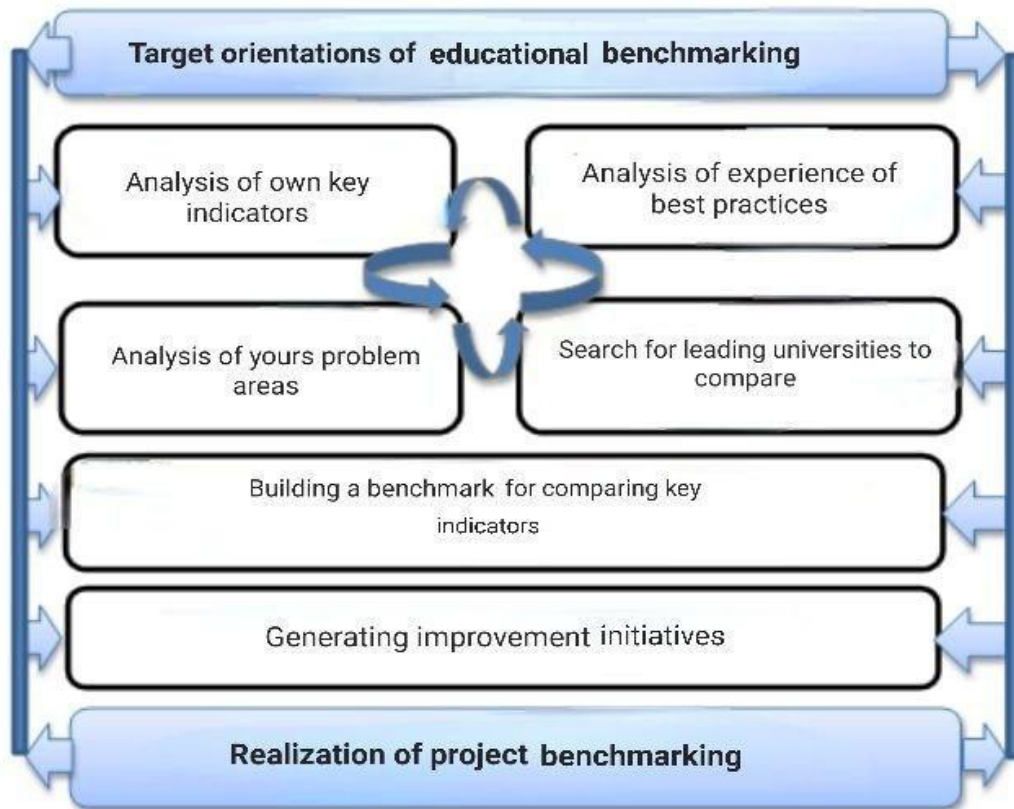


Fig. 3.4. Target orientations of educational institution benchmarking

The desire to promote their educational products on the international market and attract foreign students forces educational organizations to look for new methods and ways of popularizing their programs on the foreign market. At the same time, organizations need to remember not only the competitiveness and effectiveness of their activities on the foreign market, but also the values in relation to customers. Choosing the right approach and methodology is critical to meeting the needs of educational process management and educational programs for various stakeholders. The most common methods are the traditional waterfall method, the Agile Project Management method, or a hybrid model where both methods are used. [17] In this study, we will look at organizations that use Agile methodology for organizational management and development of educational programs. We will consider the degree of implementation of the Agile methodology as an important evaluation criterion of the competitive environment. The algorithm for conducting a benchmarking analysis of the organization of educational services is presented in fig. 3.5.

Stage 1. Evaluation of the educational organization and identification of areas for improvement. The management of the organization, initiating a benchmarking project, must first understand the strategic importance of the upcoming event. It is important that the management of the educational institution competently describes the shortcomings of the organization.

Stage 2. Determination of the subject of the reference comparison. At this stage, the management decides which of the existing "weak" places will be improved. Priority should be given to the direction of activity which, as follows from the analysis of the competitive environment, is the most promising in the future.

Stage 3. Search for a reference organization. At this stage, the analysis of domestic and foreign educational institutions is carried out, the rating, means and parameters of their competitive advantage are determined. There may be several such organizations, in which case a collective standard is formed.

Stage 4. The collection and analysis of information about the leaders of the educational market is carried out with the help of an expert survey. Experts are chosen from among the heads of the educational institution and friendly organizations, they are asked to fill out questionnaires, the questions reveal the experts' vision of the success of the organization.

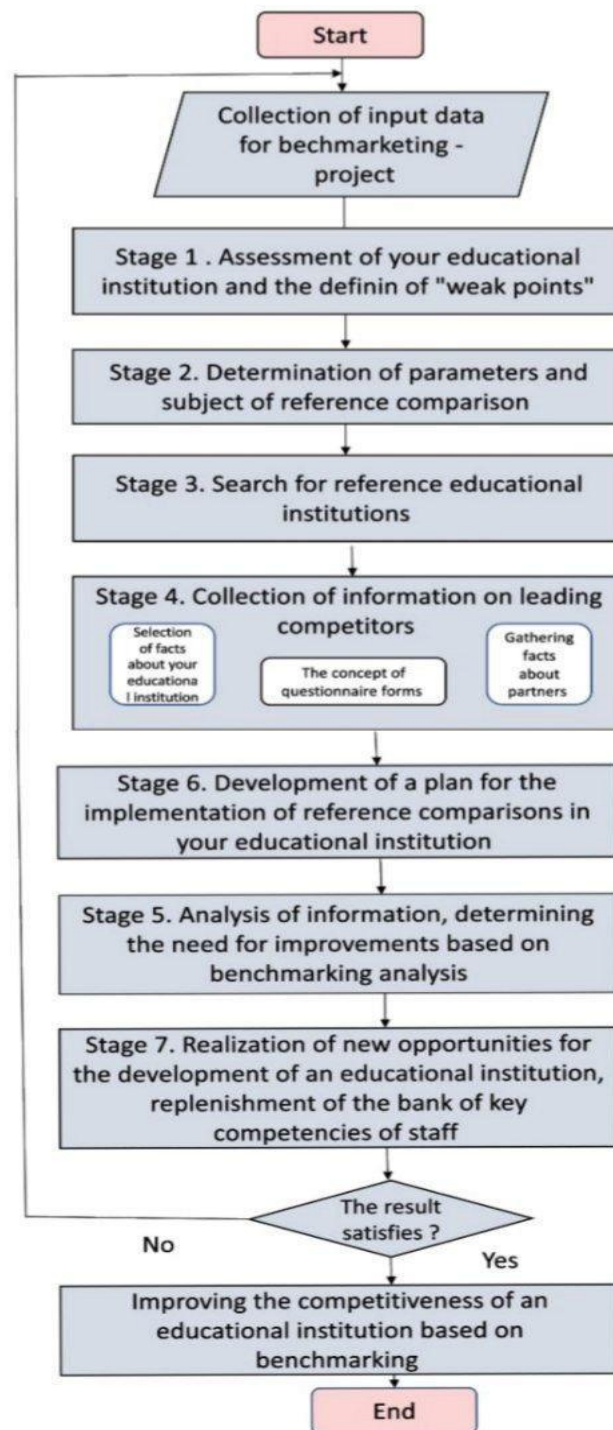


Fig. 3.5. Algorithm for benchmarking analysis by an educational organization

The algorithm is based on an approach based on the following seven stages:

Stage 5. Analysis of information, determination of feasibility of implementation of improvements based on benchmarking analysis. This stage is crucial and largely determines the effectiveness of the entire benchmarking project in general. Information received from experts is processed and analyzed, and the information bank is

supplemented with primary data of a statistical nature, reflecting the ranking positions of world education leaders.

Stage 6. Development of a plan for the use of reference comparisons in your educational institution. A detailed action plan for the selection and implementation of prospective improvements is developed here, as well as the amount of costs and possible sources of their financing.

Stage 7. Implementation of new opportunities for the development of the educational institution, replenishment of the base of key competences of the personnel. Implementation of the main areas of improvement, raising the qualifications of scientific and teaching staff. This is practically the final stage at which the educational institution can see the first results of the implemented benchmarking project. If the result is satisfactory, then the benchmarking project can be completed, and the educational institution fills in insufficient competencies due to the experience of other educational organizations. If the result does not satisfy the management, the cycle must be repeated.

Since international cooperation is associated with quite large costs, educational institutions need to constantly monitor the main indicators characterizing this activity from the "cost-result" position. The benchmarking project is not always accompanied by further independent implementation of the necessary improvements in the activities of the educational institution for various reasons: insufficient amount of own resources, organizational abilities and competencies. In this case, the educational organization resorts to searching for a strategic partner and entering into international cooperation. The algorithm for choosing a partner for international cooperation by an educational institution is shown in fig. 3.6.

The first step in choosing a partner for international cooperation is the collection of initial data on the world's leading educational institutions. Next, it is necessary to conduct a benchmarking analysis to identify the experience of best practices. On the basis of the received data, the primary selection of educational organizations for reference comparisons is made and a database of potential partners is formed.

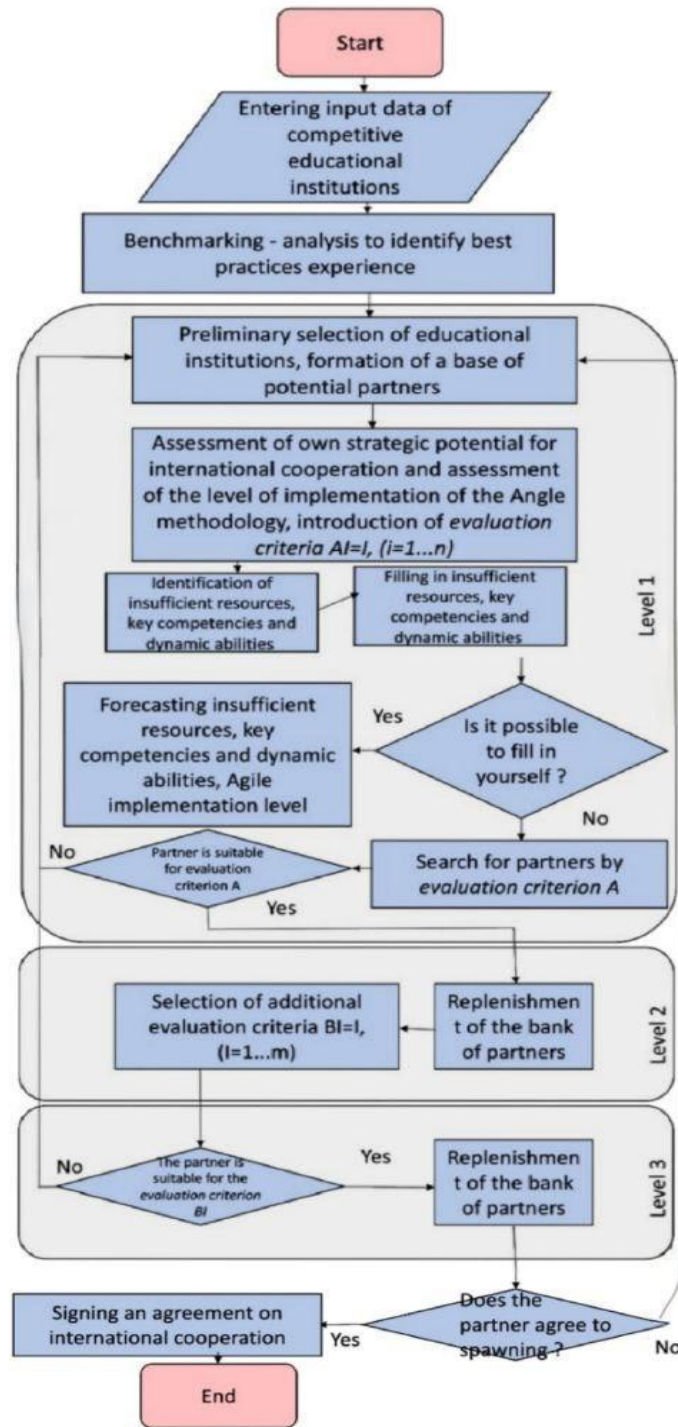


Fig. 3.6. Algorithm for choosing a partner for international cooperation by an educational institution

The next step is to assess one's own strategic potential of international cooperation and the level of implementation of the Agile methodology.

On this basis, resources, dynamic capabilities and competences are determined, and the issue of replenishing them with our own forces is decided. If such replenishment is possible, then planning and development of the project for their filling is carried out. If there are no such opportunities, then a search for potential partners is conducted according to evaluation criteria, and after that, the second level of the base of potential partners is formed. If the partner does not fit according to the previously selected criteria, additional criteria are introduced, which may include various parameters of the partner that were not taken into account earlier. On the basis of these criteria, the third level of potential partners is formed, the choice is narrowed, and at the 3rd level, the most acceptable partners are chosen and negotiations begin. If the foreign partner agrees, an agreement on international cooperation is signed. The method of partner benchmarking in the development of international joint educational projects based on the Agile methodology is presented in the form of a typology of business models (Fig. 3.7).

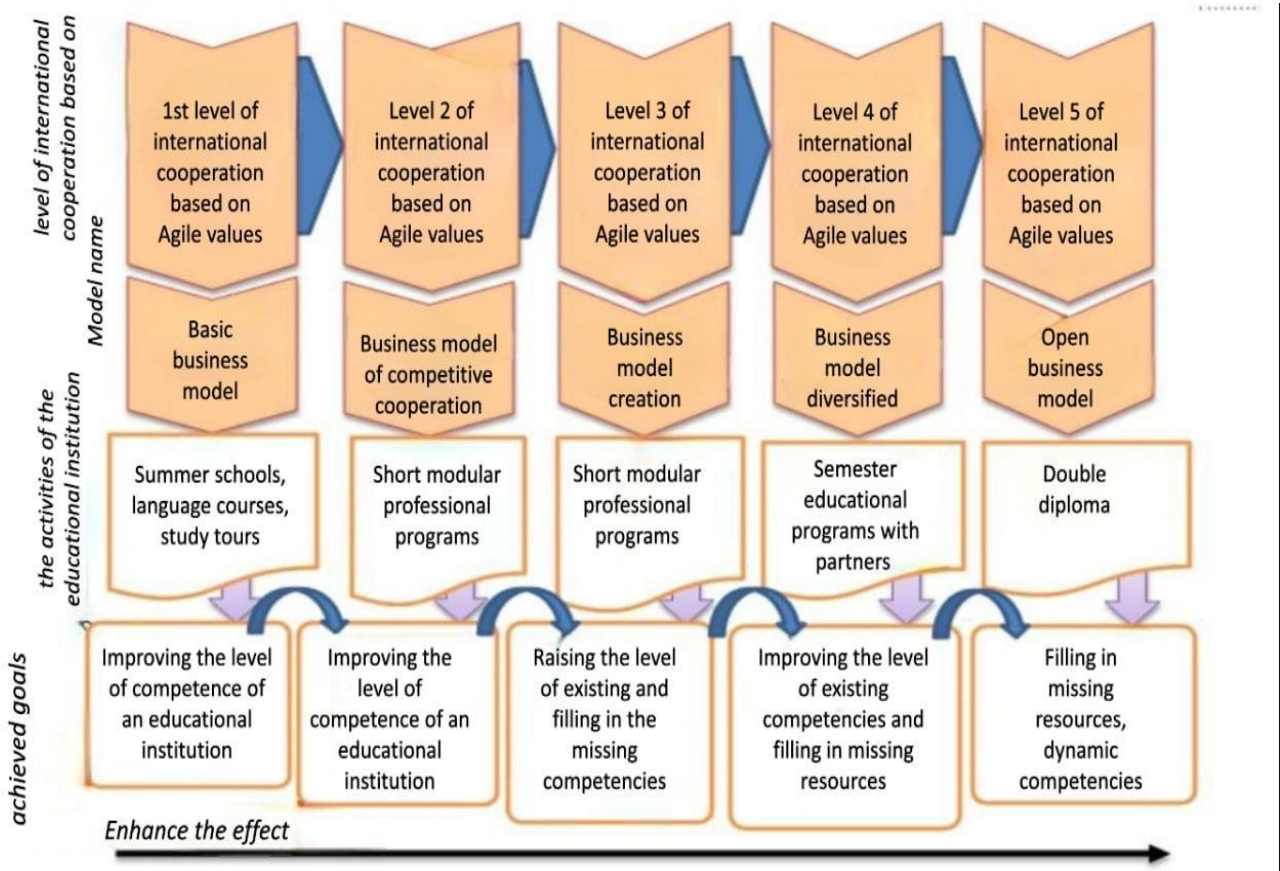


Fig. 3.7. Methodology of partner benchmarking in the development of international joint educational projects based on the Agile methodology.

The typology is based on the identification of templates of business models and compliance with certain types of international cooperation of the activities of educational institutions and is an evaluation scale according to which the ability of an educational institution to integrate into the international educational space can be assessed.

3.3. A model of marketing planning for the sale of educational services

3.3.1. Expert evaluation of strategies for the development of universities

Based on the results of partner benchmarking in the development of international joint educational projects and the identification of potential partners, it is suggested to proceed to the next step, marketing planning and sales forecast of educational services at the international level. The first step to identifying the priority segments of an educational institution is to formulate an activity strategy. According to M. Porter, "strategy is the creation of a unique and advantageous position, which involves a certain set of activities. The essence of strategic positioning is the choice of activities that are different from the activities of competitors" [45]. That is, after defining the segments, identifying the priority ones that the higher educational institution will focus on, it should implement the positioning of educational services to meet the needs of these segments.

There are many definitions of service positioning today. They all agree that in the process of positioning, the educational service occupies a certain position in the minds of consumers against similar competing educational services. The purpose of positioning is to give educational services or higher education institutions a generally beneficial, distinctive meaning in the eyes of the buyer. It should also be taken into account that the position chosen should correspond to the benefits of educational services and the existing or anticipated perception of consumers. Therefore, the key figures regarding the strategy and concept of positioning of the educational service are

the university's competitors and its consumers.

The strategic triangle shown in Appendix C illustrates the process of developing a marketing strategy. Thus, the marketing strategy for the positioning of educational services is the result of a synthesis based on the results of a situational analysis conducted for the relevant segment. The forms of situational analysis can be different (portfolio, competitive, analysis of directions for improving the educational product, etc.), and in order to choose an approach to strategy development, you need to decide on the class of the university.

If the higher education institution is new or has a sufficient amount of idle resources, then it needs to conduct a situational analysis aimed at identifying existing and potential opportunities and threats of the market environment. SWOT analysis, focused on identifying strengths and weaknesses, opportunities and threats, has become widespread when solving similar tasks. The analysis of opportunities and threats involves obtaining information about competitors, consumers and other aspects of the external environment to determine opportunities for meeting the needs of consumers and potential threats to educational services. These are factors external to the university that are beyond its control. Having assessed the strengths and weaknesses of the higher education institution, we will determine whether it is able to take advantage of the identified opportunities that are opening up. Depending on the strengths and weaknesses of the university, the same development trend can be both a threat and a new favorable opportunity. Accounting for its specific strengths and weaknesses in comparison with the most dangerous competitors can make corrections in the assessment given by a higher educational institution of the attractiveness of a particular market segment. SWOT analysis focuses on the features of the internal and external environment, which are related to the key success factors. A SWOT analysis must meet the following requirements:

- its orientation, first of all, on the subjects of the specialist formation system;
- ranking of elements of arrays of SWOT analysis;
- Inclusion in the analysis of only the main aspects;
- evidence of assessments;

- Consideration of strengths and weaknesses in relation to competitors;
- when identifying opportunities and threats, it should be taken into account that the same trend can be considered both a threat and an opportunity.

At the same time, it is necessary to keep in mind that in reality it is impossible to take into account many factors of the external environment and the internal state of the university.

We will denote the possibilities of the marketing environment of HEI as P_1, P_2, \dots, P_n , we get a set $P = \{P_1, P_2, \dots, P_n\}$. In the same way, we will get a set: threats $D = \{D_1, D_2, \dots, D_n\}$ the strengths of the university in relation to competitors $C = \{C_1, C_2, \dots, C_n\}$; weaknesses $W = \{W_1, W_2, \dots, W_n\}$. According to the results of the SWOT analysis, we will get a set of goals $T = \{T_1, T_2, \dots, T_n\}$ improvement of the educational process (table 3.8).

Table 3.8. Matrix of SWOT analysis results

	Opportunities	Threats
Strengths	$T_{ij} \subset C * P$	$T_{2j} \subset C * D$
Weaknesses	$T_{zj} = W * P$	$T_{4j} \subset W * D$

The proposed method makes it possible to obtain information about the threats and positive opportunities of the environment, about the strengths and weaknesses of the university in relation to competitors. SWOT analysis methodology involves establishing chains of connections between elements. As a result of multiplying the elements of the arrays of SWOT analysis, we obtain prospectively possible strategic goals of higher education institutions as specific end states that should be strived for when working with a specific segment, we determine the most important of them. At the same time, the goal may be based on the desire to use a certain opportunity of the environment, taking into account the strengths of the university (a formalized theoretical-multiple description of the system of goals in this quadrant of the matrix will look like this:

$$T_{ij} \in \{P * C\} \quad T_{ij} \in P * C \quad (3.1)$$

where P - a variety of opportunities of the external environment;

C – strengths of the system;

I – quadrant of the SWOT analysis matrix;

j - sequence number of the analyzed combination in the specified quadrant.

If the trend is a threat, then the goal of higher education institutions will be a competitive struggle using the opportunities of the external environment and their strengths. Next, the goal is transformed into a strategy that determines how the goal can be achieved in a changing competitive environment. It is necessary to consider all possible pair combinations and select those that should be taken into account when developing a strategy for the behavior of higher education institutions. Regarding those pairs that were selected from the field $T_{ij} \subset C * P$, a strategy for using the strengths of higher education institutions is being developed in order to take advantage of the opportunities that have appeared in the environment (tab. 3.9).

Field (2) serves to develop a strategy that allows using the strengths of the university's internal environment to eliminate threats. Field (3) involves the development of such a strategy that allows overcoming existing weaknesses at the expense of opportunities.

For couples in the field (4), the university should develop such a strategy that would allow them to get rid of the weaknesses of the internal environment and try to prevent the looming threat.

For example, the goals revealed by the results of the analysis of the first quadrant of the SWOT analysis matrix imply the growth of higher education institutions. There are many ways to grow, so goals can be achieved using many different strategies. In general, possible strategies for conditions of a growing market are illustrated by the "Product-market" matrix [44] (see Fig. 3.8). Growth strategies are grouped on the basis of two criteria that assess the focus of the company's activities on new or existing markets; new or existing goods/services. Taking these two criteria into account, development strategies are being developed: deep market penetration, expansion of market boundaries, development of a new product - and business diversification.

Thus, in the set of G_p , possible growth strategies of HEI, a subset of G_A strategies of intensive growth is allocated, which correspond to G_{AI} strategies of deeper

introduction into the market G_{A2} — expansion of market borders, G_{A3} - development of a new educational product. $G_A = G_{A1}G_{A2}G_{A3}$. Separately, we will highlight the set of G_Y strategies of integration development (regressive, horizontal, progressive integration) and the set of G_D strategies of diversification development (concentric, horizontal, conglomerate diversification). Then we will get a set G_p of possible strategies for increasing the competitiveness of higher education institutions $G_p = \{G_A * G_I\} G_D$

According to the notations adopted above and the obtained expressions, the theoretical-multiple interpretation of the possibilities, strengths, purpose and marketing strategy of the HEI (X_{cm}) will have the form:

$$X_{cm} \subset C_{ij} \times G_p$$

(3.2)

We will illustrate the methodology of developing a marketing strategy taking into account the SWOT analysis from the example of a university. The task should be solved in several stages.

According to the results of the marketing research of the competitors of HEI within the framework of the work of the forum "XIV International Scientific and Practical Conference "Higher Education of Ukraine in the context of integration into the European educational space", the study of the quality of educational services within the framework of an international project, as well as the data of the educational and methodological department of the HEI was opportunities and threats, strengths and weaknesses of HEI are revealed. Within the array of "opportunities" (P), Threats (D), strengths (C), Weaknesses (W), the following elements can be named (table 3.9).

Table 3.9. The values of the arrays "opportunities" (P), "threats" (D), "strengths" (C), "weaknesses" (W).

opportunities	threats
P_1 - growing demand for educational	D_1 - the rate of market growth in each

<p>services of HEI;</p> <p>P_2 - the need for classical education in full-time and extramural forms, but also in a more differentiated approach;</p> <p>P_3 - the opportunity to expand the range of services provided in order to meet the needs of more customers;</p> <p>P_4 - serving additional groups of consumers who are most sensitive to the price, the output of new consumer segments.</p>	<p>subsequent year slows down compared to the previous one;</p> <p>D_2 - a large and active competitor - HEI - as a threat to the implementation of an independent marketing policy, taking into account the oligopolistic type of the market;</p> <p>D_3 - dependence on socio-demographic changes taking place in the region: population aging, migration and other processes.</p>
strengths	weak sides
<p>C_1 - recognized leader status;</p> <p>C_2 - strong personnel potential;</p> <p>C_3 - availability of necessary resources;</p> <p>C_4 - constant expansion of the range of educational services, availability of top specialties;</p> <p>C_5 - high quality training of specialists, especially programmers and project managers.</p>	<p>W_1 - "lack of purposeful and pre-planned marketing policy, research is not conducted regularly";</p> <p>W_2 - low quality training in a number of specialties";</p> <p>W_3 - lack of organized marketing communications for the purpose of forming social loyalty;</p> <p>W_4 - in comparison, the HEI choice of forms of education (absence of evening, distance education);</p> <p>W_5 - a small element of flexibility in the price policy;</p> <p>W_6 - weakly developed connections with large enterprises of the city and region regarding educational and industrial practice by students of HEI.</p>

Within the framework of the ratio "opportunities-strengths", i.e. the first field of the matrix of SWOT analysis, as a reference point for defining goals and further development of alternative strategies of universities, the following combinations of elements of the matrix are of interest (Fig. 3.8).

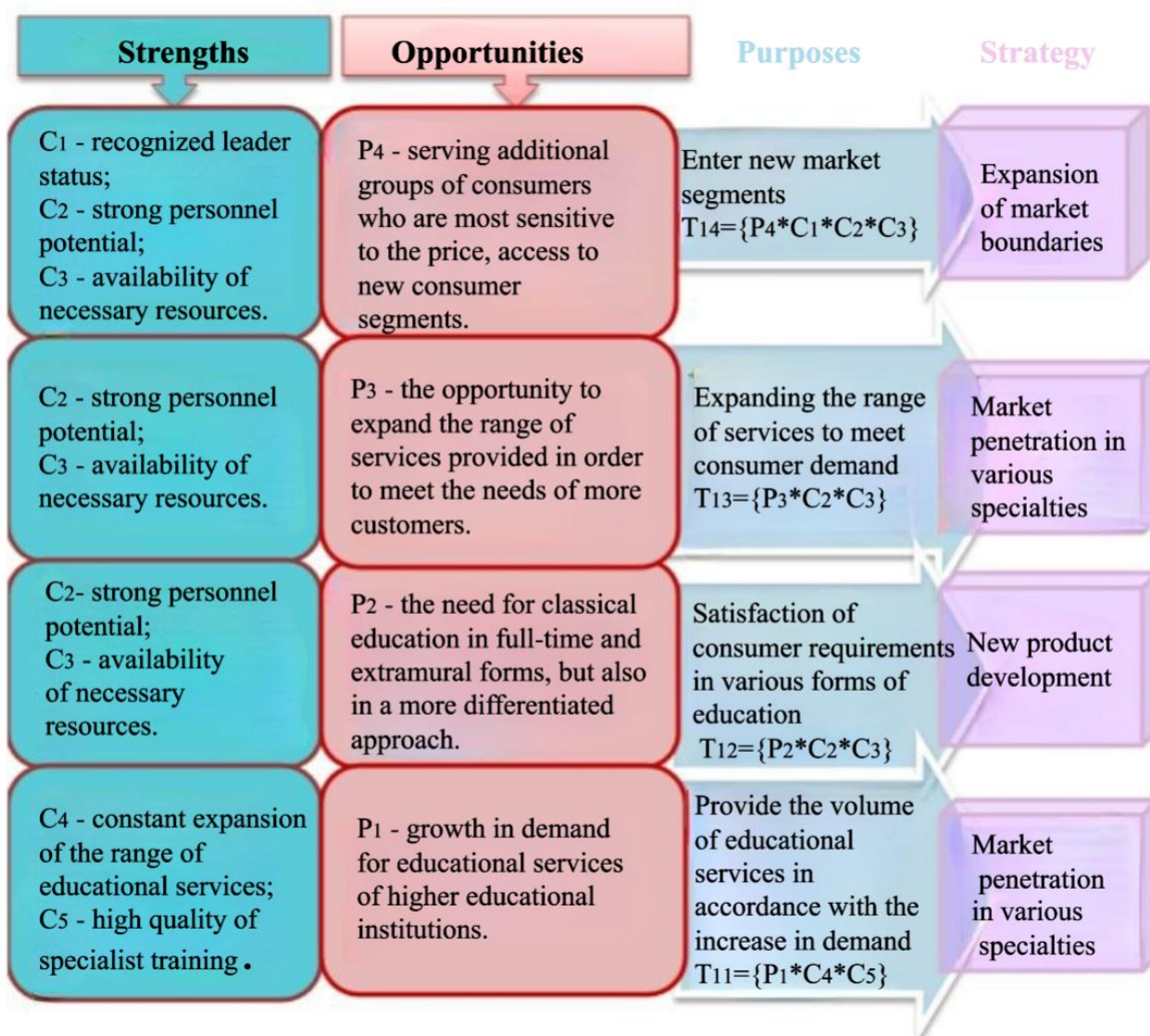


Fig. 3.8. Connection of elements of SWOT analysis with strategies

"Increasing demand for educational services of HEI"

(Option P₁) - "constant expansion of the range of educational services, availability of rare specialties; high quality training of specialists in legal and economic specialties" (strengths of the university: C4 and C5, respectively). Thus, using the opportunity that opens up, which consists in the growth of demand for services, it is advisable to introduce new specialties, meeting the requirements of the market, and new forms of education. The intersection of elements determines the goal - to ensure the increase in the production of demanded educational services in accordance with the increasing demand. To achieve the set goal, it is necessary to solve a number of tasks regarding the use of the strengths of the HEI:

- expand the range of in-demand educational services;
- to ensure high quality training of specialists in the specialties demanded by consumers.

The theoretical multiple description of the goal in this case will look like this:

$$T_{11} = \{P_1, C_4 * C_5\} \quad (3.3)$$

"the need for classical education in full-time and extramural forms, but also for a more differentiated approach" (possibility P_2) - "strong personnel potential" (strength C_2), "availability of the necessary resources" (strength C_3). New opportunities in the market of educational services for higher education institutions - application of Agile methodology for distance learning as another form of education; the university's strengths are not only the availability of the necessary specialists (staff potential of the faculty of information technologies and telecommunications), but also the latest information technologies, modern application software packages, computers, its own Internet Center, marketing specialists who are able to ensure competent promotion of educational services. It is obvious that it is necessary to increase the potential of universities in the field of distance education, while not weakening attention to the main forms of education. Thus, the goal of development is to meet needs in various forms of education. To achieve it, it is necessary to use the strengths of the university, that is, to solve the following tasks:

$$T_{12} = \{P_2 \times C_2 \times C_3\} \quad (3.4)$$

"the possibility to expand the range of services in order to meet more needs" (opportunity P_3) — "strong personnel potential" (strength C_2), "availability of the necessary resources" (strength C_3). It should be noted that work in this direction is ongoing. Every year, HEI recruits for new specialties, and new professional development programs appear. The goal is to meet the growing demand for educational services by expanding the range of services:

$$T_{13} = P \times C_2 \times C_3 \quad (3.5)$$

In order to achieve the set goal, it is necessary to solve the task of using the relevant

strengths of the university. "serving additional groups of consumers who are most sensitive to the price, reaching new consumer segments" (opportunity P4) - "strong personnel potential", "availability of necessary resources", "status of a recognized leader" (strengths C₁, C₂, C₃, respectively). Thus, the HEI can cover the segment of consumers with the level of prices for educational services provided, from 31,000 to 45,000 UAH per year (see Appendix D), which is a potential field of activity diversification. For this, it is necessary to develop an appropriate pricing policy that meets the needs of the specified segment, while not to the detriment of consumer groups that are already served. In this case, the goal of HEI development will be to enter new market segments that are most sensitive to price:

(3.6)

What is possible when regarding the use of the specified strengths of higher $T_{14} = \{P_4 \times C_1 \times C_2 \times C_3\}$

The strategies illustrated by the Ansoff matrix (Fig. 3.8) correspond to the identified strategic goals of the university.

The evaluation of the selected strategies according to the specified criteria was carried out by an expert group of five people (Table 3.10).

Table 3.10. Expert assessment of growth strategies

№	Name	Parameter weight	Option strategy			
			1	2	3	4
1	2	3	4	5	6	7
1.	Sources of competitive advantages:					
1.1.	Maximum use of the strengths of the HEI	0,3	30	7	25	6
1.2.	Sufficient resources	0,07	15	12	20	4
2.	Attractiveness of the strategy:					

2.1.	Accounting for the position held in the industry	0,05	10	2	8	2
2.2.	Maximizing the opportunities of the marketing environment	0,3	25	4	20	6
2.3.	The possibility of copying the strategy by competitors.	0,1	4	25	7	27
2.4.	Risk level	0,08	4	30	8	30
2.5.	Flexibility and adaptability	0,1	12	6	10	25
The amount according to the first indicator			10,05	2,94	8,9	2,08
The amount according to the second indicator			9,92	8,2	8,74	7,5

When evaluating strategies, experts took into account the indirect influence of other elements of the SWOT analysis matrix, which are not included in the first quadrant of the matrix (threats and weaknesses). As a result, hypotheses of the interrelationship of strategies with probable benefits and negative consequences were worked out in order to determine unplanned consequences, consistency with the previous policy of the HEI.

It is obvious that the strategy of deep penetration into the market is the most expedient to use in order to ensure the increase in the production of demanded educational services in accordance with the increasing demand. The third strategy is possible to implement next. Thus, the marketing strategy of the higher education institution, formulated based on the results of the SWOT analysis, combines the goals,

strengths and weaknesses of the higher education institution, opportunities and threats present in the market, establishing a cause-and-effect relationship between the specified elements.

If a higher educational institution feels fierce competition and at the same time lags behind its competitors, then it needs to conduct a competitive analysis. The purpose of such an analysis is to establish what advantage a HEI and its educational services can achieve, and to assess to what extent this advantage can be defended in a specific competitive situation. A HEI can realize its advantages in a specific competitive situation by using typical competitive strategies [45].

To carry out this kind of competitive analysis, various methods have been developed using matrices and various indicators of attractiveness and competitiveness (the Boston Consulting Group (BCG) method, the "attractiveness-competitiveness matrix" method of General Electric and McKinsey, etc...). To accurately measure the attractiveness potential of the market segment and the competitiveness of the university and its educational services, it is appropriate to use the "attractiveness-competitiveness" matrix of the General Electric and McKinsey firms (see Fig. 3.9).

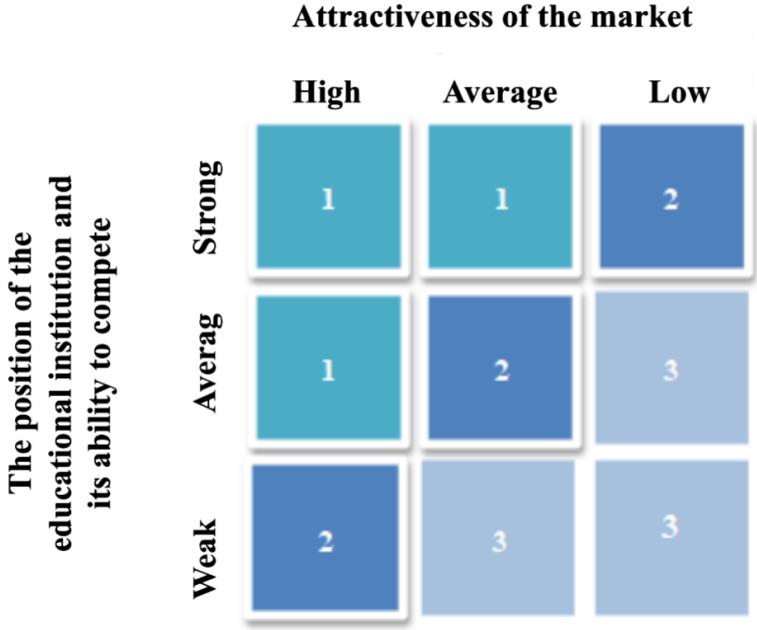


Fig. 3.9. Matrix "General Electric" - "McKinsey"

During the analysis of the threats of new competitors, the following are evaluated: economies of scale; the popularity of the HEI brand and the differentiation of educational services; capital needs when transitioning from one educational service to another; factor advantages; influence of government policy and business entities. The analysis of competition in the industry involves taking into account: the dynamics of the development of the industry, its growth; fixed costs, added value, transition cost; differences in educational services of different universities, availability of information; popularity of HEI; obstacles to leaving the market.

When analyzing the threats of substitute services, the following are evaluated: prices for substitutes and the cost of reorientation to them; propensity of buyers to use substitutes. Analyzing the influence of buyers, the following are taken into account: the dependence of the demand price on the popularity of the HEI, the efficiency of the activity and the profit of the buyers, the stimulation of the people who make the purchase decision; concentration of buyers and universities, costs of reorientation of buyers, their awareness

The vertically deferred assessment of the positions of a strategic business unit (SBU) in [46, 47] proposes to determine, on the basis of an internal analysis of the assets and competencies of the business unit, in comparison with competitors by such indicators as organization, growth, share in the segment, customer loyalty, profit margin, distribution, technological skills, patents, marketing, flexibility.

The exact definition of the evaluated indicators is a process specific to each specific higher education institution and requires compliance with the following conditions:

- the evaluation of the competitiveness of HEIs is carried out expertly in comparison with the most dangerous competitor;
- indicators are used taking into account weighting factors, which must be the same for all comparable market segments;
- it is desirable that the assessments reflect the current, but also the expected level of indicators;
- based on the results of the analysis, a final assessment is made that

characterizes the overall attractiveness of the educational services market segment and the competitive position of the higher in this market.

The "attractiveness-competitiveness" matrix is a formal, structured approach to comparing the strengths of HEI with market opportunities. It should be noted that the method of analyzing competitiveness using the "attractiveness-competitiveness" matrix is quite flexible, since the indicators are selected from a specific situation. The received expert assessments are compared in order to check their consistency or to identify the reasons for the discrepancy. As a result of the analysis, we get a graphic assessment of the competitive strategy of HEI regarding various educational programs in order to choose the best ones. So, if the HEI is located in the type 1 quadrant, then it needs to increase growth-oriented investments. When the position and attractiveness are evaluated negatively, a strategy of "harvesting" or divesting the business is recommended. When a HEI falls into the type 2 quadrant, investment decisions should be made selectively, only if there is reason to believe that the invested funds will bring a profit.

1) If the HEI occupies a strong leading position, the synthesis of the strategy is carried out based on the results of a comparative analysis of the characteristics of the existing educational product of the HEI and the product demanded by the priority segment of consumers. At the same time, the key factors of successful positioning are:

2) clarity/clarity (the idea of positioning must be clearly expressed, taking into account both the target market and the difference);

3) sequence;

4) plausibility (the chosen advantage should be quite plausible from the point of view of target consumers);

5) competitiveness (a distinct advantage must have a competitive aspect, i.e. the intended educational services must have any quality that is absent in the competitor's educational services and represents a certain consumer value).

6) in order to find the characteristics that can be used for the repositioning of educational services of HEI, it is necessary to look at them from the buyer's point of view, since the competitive position is reproduced only in the mind of the consumer.

To accurately determine the perception of information about HEI by consumers, you can use a special tool -Brand -wheel. It is a way of representing consumer feelings about the brand. With its help, you can accurately describe these feelings, find out what they are based on, and use them in the further development of the brand. Brand-wheel uses five levels: attributes, benefits, values, personality and essence (or core) of the brand (see Fig. 3.10):

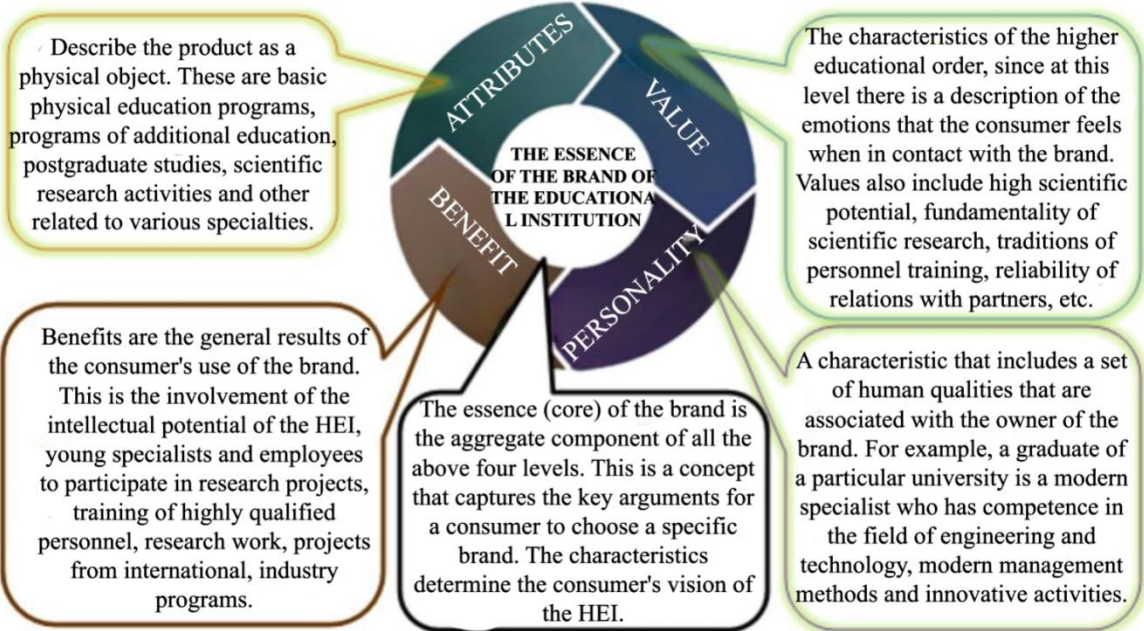


Fig. 3.10. Brand-wheel of the brand of an educational institution

The strategy of the HEI in this case is focused on improving the educational product according to the characteristics of its shortcomings and repositioning the advantages of the educational product of the HEI by improving the assortment, price, and sales communication policy

In the example, the perception map, which reflects the position occupied by the educational services of the HEI in the minds of consumers, will look like this (see Fig. 3.11):

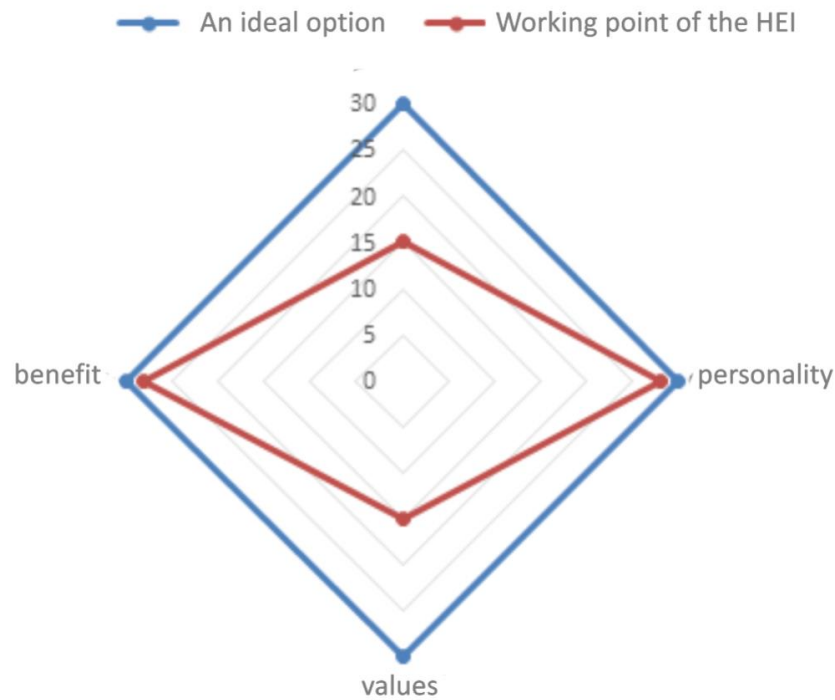


Fig. 3.11. Map of the perception of the first strategy of the HEI

As a result of the research, it was found that in order to get closer to the "ideal" perception of the university, it is advisable to finalize the following elements within the framework of the branding strategy:

1) Attributes – it is expedient for the HEI management to consider the possibility of:

- Implementation of a wider range of forms of education (for example, distance, evening forms of education);

- Application of a flexible payment schedule for training. According to the results of the analysis of the external and internal marketing environment of HEI, the prices for educational services of HEI for economic and legal specialties, chosen as the most in demand on the market of educational services, are the highest. HEI should apply the policy of differentiated pricing. Thus, the measures aimed at organizing a flexible price policy of HEI are reduced to the following:

- implementation of a discount for studies in two specialties at the same time;
- constant adherence to the policy of fixed prices at the time of receipt;
- providing the opportunity to pay for studies monthly, per semester, per year,

using an individual payment schedule;

- provision of discounts in case of successful completion of the session, seasonal discounts, etc.

These measures will help HEI to reduce the negative impact of the high price of education and attract students to enroll in a second specialty. The perception of higher product quality at a higher price reduces price sensitivity, even when the buyer is not seeking prestige or exclusivity. This is due to the fact that the consumer is unable to determine the quality of the educational service before purchasing it, and there are no other ways to determine the quality. To the consumer of an educational service, price means much more than the amount of money that the buyer must give to the seller as an inevitable part of the transaction. In such cases, price sensitivity is influenced by the price-quality effect, which suggests that the buyer is less sensitive to the price of the product to the extent that a higher price means better quality. The buyer refers to the price as an indicator of quality.

2) Values. People appreciate when a product is an identity of their personality. Therefore, an institution of higher education that can offer the consumer prestige in addition to the direct benefit of use should charge a higher price than institutions of higher education that provide the same but less prestigious educational services. It is possible to implement this with the help of communication policy, taking into account the techniques of experiential marketing.

In turn, such characteristics as "personality" and "benefits" should be brought closer from the ideal option to the working point of the HEI using experiential marketing tools within the framework of communication policy.

The selected item must contain the reason for purchasing the educational service. When developing a positioning strategy, it should be borne in mind that human nature is binary, it is both rational and emotional at the same time, our actions are largely driven by unconscious needs, or those that we ourselves do not want to be aware of, but, as a rule, they determine our choices. Today, the consumer expects the product, communications and marketing campaigns to excite his feelings, excite his soul and stir his mind, relate to him personally, fit into his lifestyle, and arouse his emotions.

Starting from visual, tactile and emotional perception, educational services should provide a wide range of sensations, give an opportunity to experience strong feelings, stimulate mental activity and influence the nature of human actions. In this way, sensory and emotional associations are formed. All this generates empirical experiences with the help of language and symbols. The marketer deals with the supply of stimuli that shape consumer experiences, that is, he selects the conductors of experiences.

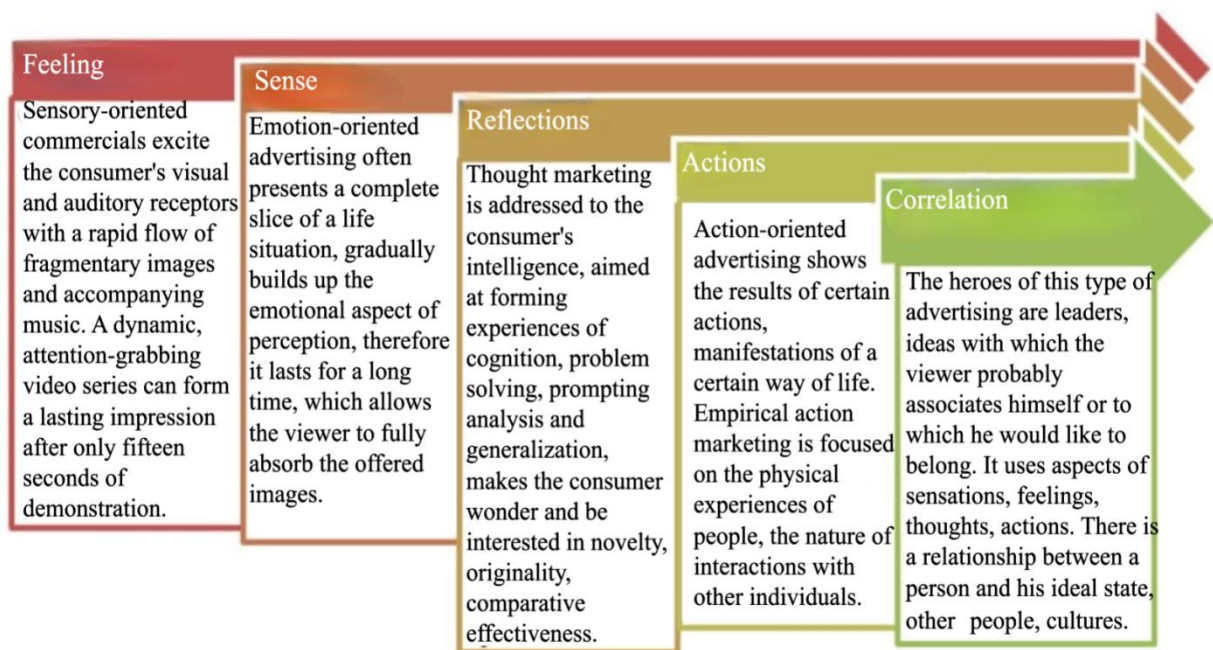


Fig. 3.12. Incentives that shape consumer experiences when choosing an educational institution

Using the mass media, it is possible to create "the desired empirical position of the educational service in the minds of consumers, which as a result will form a certain image of the HEI or brand in the consumer. Depending on the success of actions, what is done and how it is done, the university and the brand will be perceived as one or another attractive enough to arouse admiration and desire.

It should be taken into account that a person does not purchase educational services unconsciously, under the influence of some impulse. He thinks and evaluates,

and so that he does not doubt the correctness of each step, it is necessary not only to influence the personal values of the representative of the target audience, which determine the realization of his needs, not only to prove to the person the satisfaction of his own needs, but also to give him arguments with the help of which she will be able to justify her choice. And this justification must be verified, for proof it is necessary to use rational arguments, because they can be held in hands, seen, etc. Rational allows you to give a sense of logic to a statement that in its pure form can be perceived as absurd. This especially applies to the purchase of educational services. It is also necessary to take into account various groups of influence that can incline the applicant's choice in the direction of one or another higher education institution.

Thus, positioning can be based on a number of attributes that include desirable rational and emotional characteristics or benefits. The following types of reasons for positioning educational services can be distinguished:

- characteristic features;
- sought benefits;
- use - includes end use, demographic basis, psychographic or behavioral basis and popularity;
- origin (producer of educational services);
- the educational process is the object of the HEIs positioning efforts;
- support (for example, expert confirmation);
- attributes that make it possible to compare with the educational services of competing HEIs;
- Country or geographic area.

In theory, consumers can use many attributes to evaluate educational services, but the number of attributes that actually influence consumer choice tends to be small, in part because consumers can only consider attributes they are aware of." The more variables used in the positioning of a given educational service, the higher the probability of confusion and even mistrust on the part of consumers. When using one or more attributes as a basis for positioning educational services, it is important to recognize that the meaning attached to these attributes often varies. The attribute may

not strongly influence consumer preferences if all alternative educational services are perceived as approximately equal on this parameter. target market research.

For example, it seems that the elements of the "Brand Wheel" (see Fig. 3.10.) should be connected by a consistent logic. Some elements can be implemented by certain SEMs. Thus, the brand of the HEI involves the creation of the consciousness of consumers of a certain model — the image of a specialist (such characteristics of the "Brand Wheel" as values and personality). Purchasing the educational services of a particular university means moving into the world of a brand and assimilating an image, acquiring certain qualities. This can be achieved, for example, by such SEMs as sensations, feelings, thoughts (implemented in the form of a vocabulary of slogans, musical accompaniment, with the help of expressive means of language (features of vocabulary, syntax, stylistics, and even with the help of metaphors)).

SEMs actions and relationships are activated, for example, by visual images of successful and famous people who graduated from this university. These elements awaken emotions and create a mood. It should be remembered that a person evaluates a brand rationally and emotionally at the same time. Appeals to the sensual, emotional sphere are more effective, since people are much more guided by emotions, unconscious impulses, impulses than by pragmatic logic, but the importance of accounting for the rational component of decision-making is undeniable. The consumer must be able to explain the purchase of an educational service at a specific university. This is what the rational component is aimed at (such characteristics of the "Brand Wheel" as attributes and benefits), while the choice could have been made for completely different reasons.

Thus, it can be concluded that consumer analysis is one of the main elements of modern marketing, which includes market segmentation, segment prioritization, and product positioning. After you have segmented and prioritized, you should learn what your target customers want and who they are. consider most important when making a purchase decision; to develop educational services that meet exactly these needs and expectations; to assess the perception of target buyers of competing educational services in the selected segment(s) of the market; based on the characteristics of

educational services, the needs and expectations of target customers and their perception of the positioning of competitors, choose an image that will distinguish our educational services from competing ones, while taking into account the preferences of target customers.

Moreover, the position taken by the consumer of any educational service is a complex set of perceptions, impressions and feelings that he has when comparing this educational service with competing ones. In this, you should influence human emotions with the help of experiential marketing tools, and even provide rational arguments. The positioning procedure can be presented schematically in the form of the following stages (Fig. 3.13):

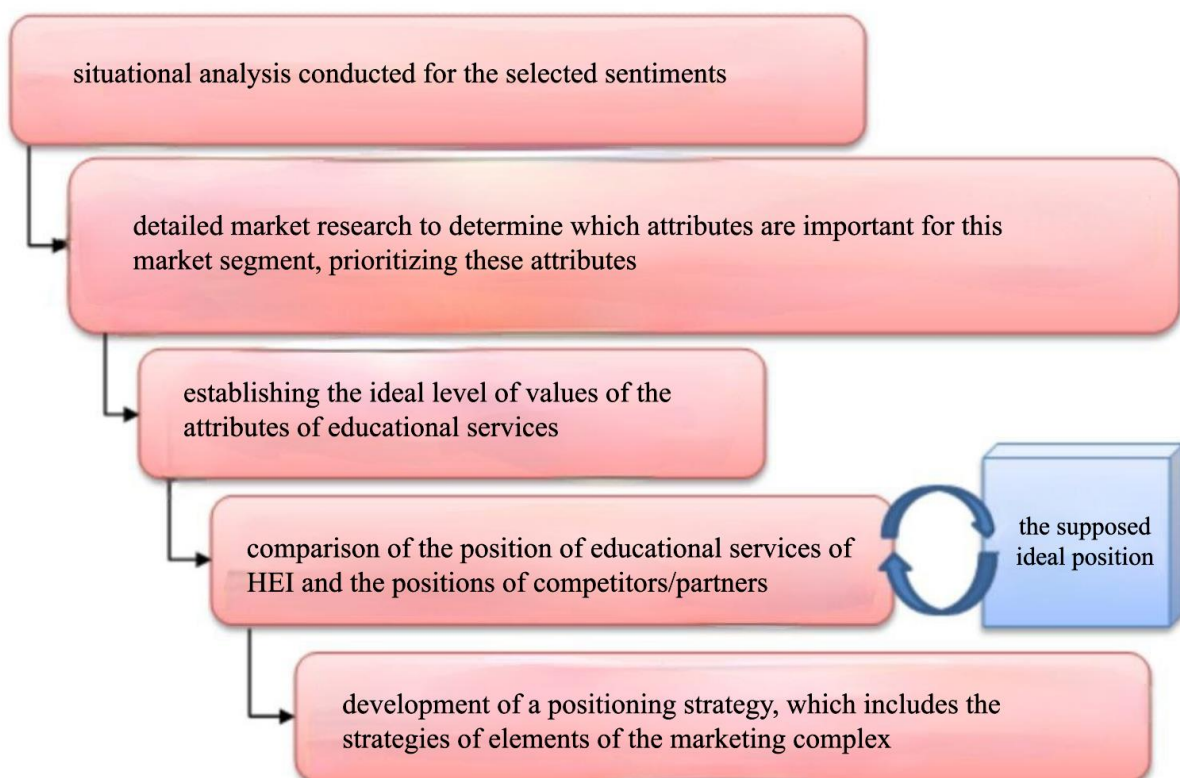


Fig. 3.13. Positioning procedure of the HEI

Thus, the development of a positioning strategy involves working out all the details of the marketing complex for effective positioning of educational services: the strategy of services, communications, distribution and pricing. Knowing the key factor of the marketing mix allows you to emphasize it when developing a strategy. The

entire marketing mix is important for effective positioning. The characteristics of educational services, their price and distribution channels all play a role, but promotional activities are the most essential element, as they are the mechanism by which positioning is directed to the target audience. The positioning of educational services consists in choosing such product parameters and elements of the marketing mix that, from the point of view of target consumers, will provide educational services with competitive advantages. The positioning strategy allows you to achieve excellent competitive advantages. Positioning strategy is a marketing activity for the selection of target segments that define the areas of competition and distinctive advantages that determine the methods of competitive struggle.

3.3.2. Marketing complex of the HEI

Segmentation and selection of target markets are two key elements of marketing planning. Determining the target markets of HEI determines the setting of tactical goals and the choice of a positioning strategy. In turn, the positioning of the educational product of the HEI consists in choosing such elements of the marketing complex that, from the point of view of target consumers, will provide the highest competitive advantages.

The analysis of marketing strategies of HEI (see Fig. 3.8) aimed at solving positioning tasks prompts the formulation of a marketing complex. The strategy of entering the market of educational services is aimed at maintaining the advantages of the educational product of the HEI over competitive ones, already obtained thanks to its successful sale. This strategy is effective when the market for educational services is saturated. To strengthen the position of the service, you can increase advertising, lower prices, expand distribution and modify the service. The placement of accents will depend on the strategic goal.

The placement of accents will depend on the strategic goal. For example, in accordance with the strategy of deep penetration of the market, when implementing the goal of increasing the production of in-demand educational services in accordance

with the increasing demand, it is advisable to create an impression of the exclusivity of the educational services of HEIs in economic and legal specialties. One of the main tasks of positioning the educational services of the university will be its identification as a producer of high-quality education services. As part of the marketing complex, this will be facilitated by the price strategy of high prices for the indicated specialties, which is already being implemented by the HEI. The goal for the product will be to preserve its quality while adding new features (new forms of learning, establishing marketing communications with the target audience). As part of the promotion strategy, the main goal will be to attract new consumers and create a positive image. Thus, a key element of the strategy is image creation, that is, measures to form and consolidate the brand of the HEI as a producer of high-quality, exceptional educational services in economic and legal specialties.

The implementation of the same strategy, but in order to meet the growing demand for educational services by expanding the range of services, involves an emphasis on the product and pricing policy in the marketing mix. As part of the product, it is possible to use the evening, distance, correspondence form of education in specialties that have a stable demand, expanding the range of educational services (in particular, additional education). At the same time, the goal of the service is also to preserve its quality, but with the addition of new features. As part of the pricing strategy, it is advisable to develop a flexible payment schedule for education with the provision of all kinds of discounts in order to encourage as many consumers as possible to apply to HEI.

In accordance with the strategy of deep penetration of the market in the implementation of the goal of increasing the production of in-demand educational services in accordance with the growth of demand, a key element of the strategy is measures to form and consolidate the brand of the HEI as a producer of high-quality, exceptional educational services in economic and legal specialties

It should be taken into account that each international market of educational services has its own distinctive features, according to which the specifics of the elements of the marketing complex are set. Decisions about a specific element must be

carefully linked with decisions of other elements of the marketing mix. The basis for such coordination is the segmentation and positioning strategies, since it is in them that the main direction of all marketing components is set. Knowing the key factor of a successful marketing mix allows you to emphasize it when developing a marketing strategy of a regional HEI.

Thus, some elements of the marketing complex are important for the effective positioning of a commercial university, while others are important for a non-commercial one. The number of theoretically possible combinations of elements of the marketing complex is infinite. In any marketing strategy, the four elements of the marketing mix are inevitably present and play a useful role; however, usually their roles are not equal to 1. The formalized expression of the effect of the marketing complex on the criterion indicator of the effectiveness of marketing management of the educational process looks like this:

$$KM = \sum_{i=1}^n a_i * P_i \quad (3.7)$$

where a_i - the importance of the i -th element of the marketing complex; P_i - assessment of the effectiveness of the element of the marketing complex; $n = 4$.

The choice of the driving element of the strategy affects how the interrelationship between the various elements of the marketing mix will subsequently be distributed. When determining the main components of the marketing complex and their importance, it is necessary to take into account: the positions of HEI in the competition, the stage of the product life cycle, the results of segmentation and prioritization. This allows for prompt correction of the developed marketing complex, thus determining the competitiveness of universities on the regional market of educational services.

As a rule, the product is the central part of the marketing mix of the HEI, and its concept is developed first. Despite a significant number of publications, there are still no generally accepted ideas about the essence of the product of HEI. Meanwhile, the development of marketing tools should be based on a clear understanding of the proposed service and its marketing potential. One of the methods used in the scientific

literature to describe a service within the framework of economic theory is the marketing method, which involves "description of the object as a subject of consumption (consumer utility - consumer value)."

At the same time, market subjects judge the quality of the HEI product on the basis of the result: to what extent the graduate's training meets market requirements. Therefore, the product of the university includes the "graduate" as its main component. It is possible to identify the degree of development of the product of the HEI (specialist) according to the criterion of competitiveness. It should be taken into account that the competitiveness of an educational product is determined only by those properties that are of significant interest to the consumer. All indicators that go beyond this framework (in particular, reflecting the interests of the manufacturer) should not be considered when assessing competitiveness as those that do not increase the value of the product.

To analyze the competitiveness of HEI, it is necessary:

1. Define objects of comparison.
2. Distinguish the goals and tasks of assessment.
3. Identify sources of information.
4. Determine the list of indicators to be evaluated.
5. Rank indicators by level of significance.
6. Evaluate the educational product, while if direct quantitative evaluations are possible, the indicators are presented in quantitative indicators; qualitative indicators are expressed by conditional quantitative assessments (points).
7. Choose the basis of comparison (customer needs, product of a leading university competitor, etc.).
8. Make a comparison.
9. Calculate the general indicator of competitiveness.

A comprehensive method of assessing competitiveness involves calculation of the generalized indicator according to regulatory, qualitative and economic parameters. The calculation of the generalized criterion of normative parameters (I_{HII}) is carried out according to the formula:

$$I_{HII} = \sum_{i=1}^n q_i \quad (3.8)$$

where q_i - indicator of competitiveness according to the i -th regulatory parameter (availability of a license for this field of training, compliance of the curriculum with the current state standard). At the same time, if at least one of the indicators is equal to 0, then the group indicator is also equal to 0, and the product of the HEI is uncompetitive.

In order to calculate the generalized qualitative criterion, it is necessary to identify the list of indicators to be evaluated. In accordance with the marketing approach of identifying in-demand specialists, it is necessary to assess the attractiveness of specialties for consumers of educational services (both applicants and employers), and the presence of competitive advantages. The requirements of employers are given in [48]. Professional qualities formed by HEIs with high positive evaluations are the most popular. The formation of such qualities of higher education institutions ensures the competitiveness of a young specialist in the labor market. Currently, they include the following opportunities: the ability to work under pressure, in a stressful situation; manage the work of others; work in a group; work on a computer and on the Internet; find new ideas. The professional qualities of qualified specialists, adequate to the current requirements of employers, have zero marks. Professional qualities with negative evaluations in the existing form are not needed, they need to be corrected, as they reduce the competitiveness of a higher education graduate. According to the obtained data, the ability to "effectively" use the working time of the class (the organization of the young specialist) and the underdevelopment of his basic professional qualities have a negative impact on the salary of a young specialist. The formed level of these professional qualities is the main reason for the low competitiveness and salary of their owner.

Therefore, the basis of the attractiveness of the specialty is its demand in the labor market, including the position of the labor market and the functions performed.

"The preferred choice of a future specialist is also based on the competitive advantage of one specialty compared to another. An indicator of competitive advantage will be a higher level of income, i.e. salary wages received by an employed person in a specific profession". So, how do the criteria for the effectiveness of education (demand for educational services) act

1. Demand for a specialist on the regional labor market.
2. The position held in the labor market, including the performed functions and the required level of education.
3. Salary level.

The assessment of the generalized qualitative criterion (I_{KII}) is based on the identified private efficiency criteria, the weights of which influence the generalized criterion are different. Therefore, it is advisable to calculate I_m according to the formula:

$$I_{KII} = \sum_{i=1}^n q_i * a_i \tag{3.9}$$

where q_i - point assessment of the i-th criterion of demand for the graduate's competitiveness;

a_i - the weight of i-th criterion

The obtained generalized criterion characterizes the degree of compliance of the product of the university and the products of competitors with the existing needs of the educational services market in the entire set of basic characteristics of the competitiveness of HEI graduates. The higher the value, the more fully the requests of consumers of educational services are satisfied. Determination of the importance of each criterion is carried out on the basis of expert assessments.

The calculation of the generalized criterion according to economic parameters is made taking into account the assessment of the total costs of the consumer of obtaining educational services. And here the cost of the educational program during the period of study should be taken into account; expenses for a library subscription, expenses for the purchase of methodical materials, expenses for working on the

Internet, expenses for copying; expenses for additional educational services; other expenses. The total costs of the consumer (3) are determined by the following formula:

$$3 = \sum_{i=1}^T 3_i + \sum_{i=1}^T C_i \quad (3.10)$$

where 3_i - expenses for the purchase of an educational program, belonging to the i -th year of its receipt;

C_i - average total expenses for educational consumption programs belonging to the i -th year of its receipt;

T — term of receipt;

i - year is fine. With

$$C_i = \sum_{j=1}^n C_j \quad (3.11)$$

where C_j - expenses for obtaining an educational program under the j -th article (for example, copying materials for term papers, working on the Internet in computer rooms, paying library subscriptions, printing term papers and abstracts, purchasing methodical manuals, etc.);

n - the number of expenditure items for obtaining an educational program. The calculation of the generalized criterion by economic parameters (I_{EII}) is performed according to the formula:

$$I_{EII} = \frac{3}{3_0} \quad (3.12)$$

where 3 , 3_0 - the full cost of the consumer in accordance with the evaluated educational program and exemplary. The calculation of the integral indicator of competitiveness (K) is performed according to the formula

$$K = I_{EII} * \frac{I_{kn}}{I_{EII}} \quad (3.13)$$

The analysis of the obtained results according to the integral indicator of competitiveness is given in table 3.12.

Table 3.12. Analysis of the integral indicator of competitiveness

The value of K	Educational program	Higher educational institution
1	2	3
> 1	The program under consideration provides an example of competitiveness and provides a smaller consumer effect.	The HEI enters the competitiveness of the benchmark university based on the characteristics of effective activity.
< 1	The competitiveness of the program in question is higher than that of the benchmark university.	The HEI has higher competitiveness than the reference one.
= 1	The competitiveness of the considered program and the benchmark are equal.	The competitiveness of HEIs is the same, that is, they have the same measure of effective activity per 1 conditional unit of income.

The K indicator is the difference between the compared educational product and the reference product in the consumer effect that comes per unit of the buyer's expenditure on the purchase of the educational program. Thus, the applied approach under consideration makes it possible to compile only two elements of the marketing higher education complex: the educational product and the price. At the same time, two more elements of the marketing complex remain unstudied: distribution and promotion. In order to obtain quantitative assessments of competitiveness, it is necessary to supplement the method with formulas for calculating the specified criteria.

The assessment of the general criterion of the efficiency of the distribution strategy () is carried out according to the order of the private criteria of efficiency, the weight of influence on which is in the general criteria of others. Therefore, it is advisable to make the calculation according to the formula:

$$I_P = \sum_{i=1}^n q_i * a_i \quad (3.14) \quad \text{based}$$

on the results of marketing research, the opinions of consumers of educational services are revealed.

where q_i - score evaluation of the i -th criterion of the effectiveness of the strategy for the distribution of educational services of HEI;

a_i — the weight of i -th criterion.

Similarly, the generalized criterion of the effectiveness of the promotion strategy (I_{Π}) occurs according to the formula:

$$I_{\Pi} = \sum_{i=1}^n q_i * a_i \quad (3.15)$$

where q_i — point assessment of the i -th criterion of promotion efficiency; a_i — the weight of i -th criterion.

The calculation formula for evaluating the effectiveness of the marketing university complex takes the form:

$$K_{KM} = a_i * \frac{I_{\kappa n} * I_{\kappa n}}{I_{\exists \Pi}} + a_i * I_p + a_i * I_n \quad (3.16)$$

At the same time, the absence of at least one of the elements of the marketing complex means non-compliance with consumer requirements.

The relevance of using the proposed approach is due to the need for a regional market of educational services, the lack of clear positioning of individual HEI, the intangibility of educational services, the complexity of their evaluation by consumers, as well as difficulties in comparison with similar educational services offered by different HEI. In turn, with the help of this approach, it is possible to overcome the effect of evaluating the quality of an educational service for its price. Analysis of competitiveness indicators allows you to assess whether the quality and price of educational programs, distribution strategies and promotion characteristics, developed

on the basis of consumer requirements and forecast market development, correspond to which components have a negative impact on competitiveness, and which have a positive effect. Also, the proposed market approach makes it possible to use specialties for work in a timely manner (due to the calculation of the generalized qualitative criterion It), to identify directions for improving positions (which criteria do not meet or do not meet the full requirements of consumers), as well as to attribute the educational product of the HEI to this or that degree. product improvement (see Fig. 3.14)

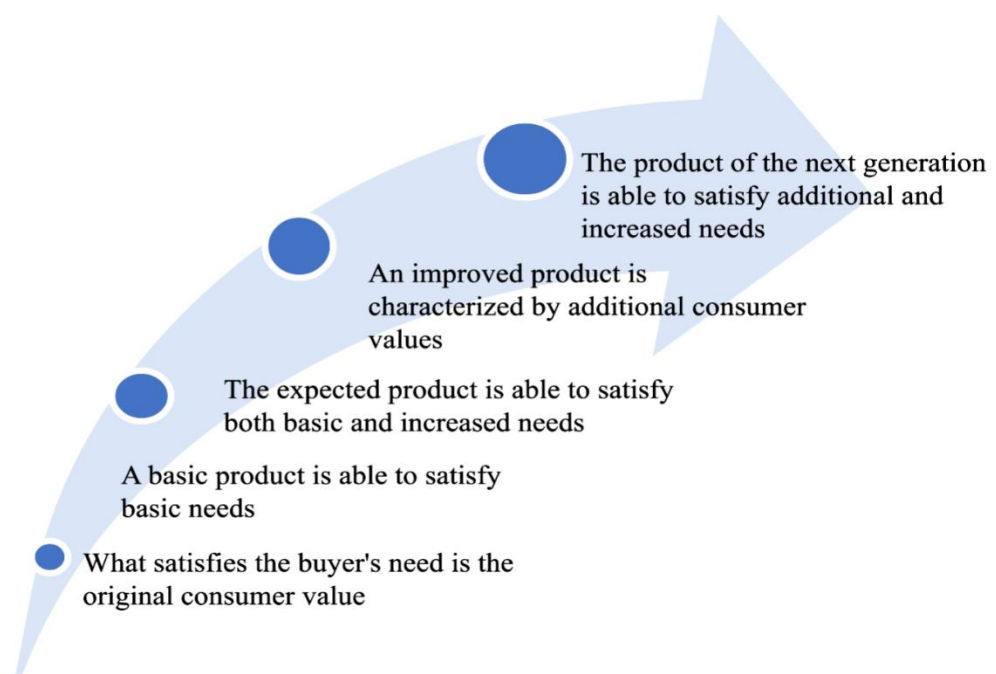


Fig. 3.14. Illustration of the process of improving the educational service

As noted in [49], education can help a person achieve such goals as obtaining means of subsistence (salary), obtaining guarantees of security in the future, realizing one's potential, etc. Thus, a person's improvement of his economic (professional) and social characteristics is necessary, which satisfies any education. The purchase of educational services of HEIs is one of the options for achieving the specified goal (for example, self-education, career growth, etc.).

"The basic product" is the compliance of the main parameters of the product

according to the level of needs and requests of consumers, which are already implemented with the help of most competitors. Training of specialists, bachelors, and masters in various specialties can be considered as the basic product of HEIs. The basic product of a HEI corresponds to a state diploma, which gives the opportunity to occupy a certain position, which indicates the social status of its holder. As the goals of obtaining an education at this stage of the evolution of the educational product, the opportunity to earn money and receive guarantees of security in the future is provided. "The means of achieving these goals are the improvement of professional, personal and civic abilities and quality of a person, his economic and social value, which is the essence of education." At this stage of the development of the product of the HEI, basic professional knowledge is formed, fixed in professional educational standards, educational programs and other normative documents. Accordingly, it is appropriate to apply methods that form basic practical and theoretical professional knowledge, abilities and skills that provide certain professional and personal qualities for the chosen type of activity at the specified higher education degree.

"The expected product is the improvement of some parameters without the deterioration of others." Modern information technologies, scientific laboratories, and scientific research units are used in the process of training on the specified evolution of the product. The knowledge acquired by students of HEI at this stage of evolution includes not only special, but also general disciplines in varying degrees of depth of study, which meets the requirements of employers. The expected product will be a specialist with such characteristics as flexibility, initiative, strategic thinking, independence, psychological stability in stressful situations.

An improved product is defined by a set of related services and its special properties. Which is, first of all, the expansion of some parameters without the deterioration of others. At this stage, the HEI develops international relations, holds scientific conferences and seminars, including international ones, and develops a system of additional professional education independently. As a result, we get a specialist with the necessary level of knowledge, skills and abilities, able to think and act informally, constantly ready for growth and self-improvement.

A potential product (next generation product) has characteristics that the consumer will not find in competitors. Accordingly, at the specified stage in the process of HEI education, it is necessary to include unique scientific equipment for conducting research in various fields of knowledge, applying new ideas, science-intensive technologies, and participating in prestigious international projects. Status, the opportunity to get a certain workplace (to overcome institutional restrictions), the product of this stage of the HEI guarantees its consumer, in addition to high wages, employment in the chosen specialty. A specialist of the "next generation" of a HEI possesses certain fundamental knowledge. Educational services provided at this level give the user the opportunity to use the results of any other intellectual services (scientific, informational, consulting) independently or at lower costs.

The application of the methodological apparatus of marketing in the field of analysis of needs, goods and services to the education system, training of certified specialists allows to determine the potential of meeting the needs offered in the specified educational field, to adjust the process of providing educational services and its provision to consumers depending on the conditions of the market environment, as well as to increase competitiveness HEI, to prepare specialists known to be created on the labor market.

Conclusions to section 3

The process of prioritization of segments of consumers of educational services involves the implementation of a number of characteristic stages: identification of separate criteria for evaluating the preference of segments of HEIs; definition of the generalized criterion identification of the attractiveness of the segment; evaluation of the criterion indicator of the efficiency of universities in elementary segments; gradual consolidation of segments with a focus on the "20/80" ratio.

The marketing strategy of positioning is the result of a synthesis based on the results of a situational analysis conducted for the relevant segment. At the same time, the forms of situational analysis can be different (portfolio, assortment, competitive,

analysis aimed at improving the product, etc.). The key factors of successful positioning are the clarity/clarity of the idea; sequence; plausibility; competitiveness; the presence of rational and emotional characteristics.

The results of the evaluation of the effectiveness of the educational institution's marketing complex make it possible to determine the potential inherent in the specified educational service, to adjust the process of its provision depending on the conditions of the market environment, to identify directions for improvement of individual elements of the marketing complex, as well as to increase the competitiveness of universities in the field of training created on the labor market of specialists.

Agile was developed and substantiated - an adapted technology of administration and flexible adjustment of the content and characteristics of an international educational project. The format of the IECP-PAM cycle management information technology introduced in the study provides a formalized description and regulation of educational, logistical, communicative, management processes based on the author's formalized indicators of the project cycle. The built technology is based on the capabilities of the Scrum approach, which allows, without a clear division into formal internal specializations, to use diverse specialists who are divided into leading management roles: Scrum master (organizer) and Product owner. With the use of the author's system of indicators, the progress of the project cycle is assessed according to four universal coordinates:

a) productivity (regarding the performance of tasks at certain stages and stations of the IECP-PAM cycle);

b) quality (in the assessment of project stakeholders, time and resources spent on creating project products);

c) forecast (regarding the values of "user stories" within micro-cycles and their combinations)

d) business value and the visualized chain of "project value core dynamics"

CHAPTER 4.

DEVELOPMENT OF AN INTEGRATED COMMUNICATION AND INFORMATION PLATFORM OF INTERNATIONAL EDUCATIONAL PROJECTS

4.1. Conceptual scheme of the integrated communication and information platform of international educational projects

During the approbation of the models presented in section 3, a specialized toolkit was developed for their implementation using the Yii2 framework using the popular PHP programming language. An SQL database was used to store data for the information platform. One of the most popular applications, phpMyAdmin, was used for database development and administration [35]. Global trends in education indicate a shift from a traditional teacher-centered approach to a student-centered approach. This alternative model focuses on what students will be able to do at the end of a module or programme, ie. on competencies and learning outcomes. Within the framework of the competence approach, one of the main results of the activity of higher education institutions is educational programs, which must be designed taking into account the requirements of the modern labor market. When developing programs, the opinion of not only the academic staff and students, but also other stakeholders, including employers and representatives of industry associations, should be taken into account. In connection with the increase in academic freedom and mobility of universities, the development of many educational programs of specialties by the country's universities began, which may differ in elective components. The diversity and substantive variation of educational programs complicates their compatibility and comparative analysis, familiarization with their content for heads of higher education institutions, professors and teaching staff, employers and other stakeholders. In this context, the systematization of educational programs is needed. In connection with this, the development of a methodology for designing and evaluating educational programs in cooperation with industry associations becomes an urgent task.

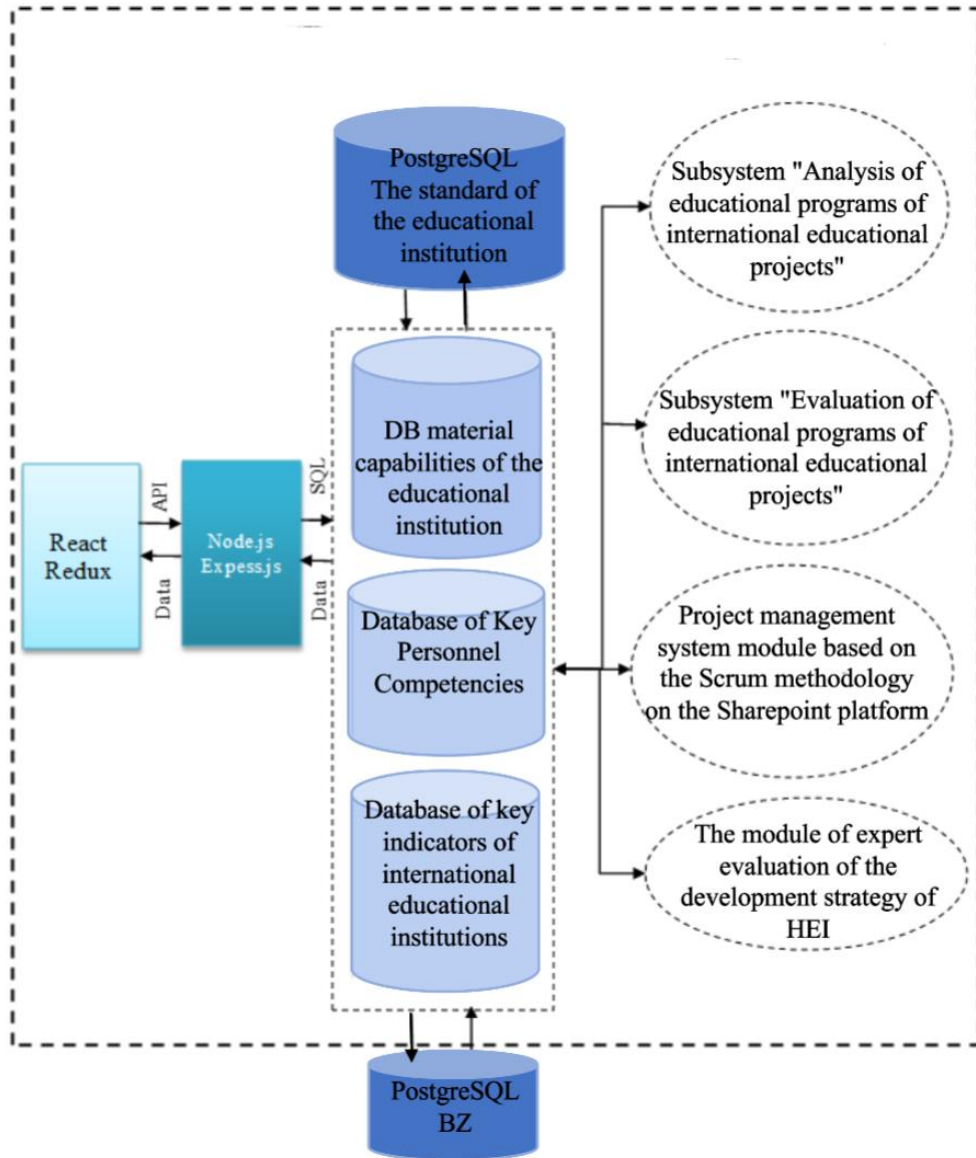


Fig. 4.1. Architecture of the communication and information platform of international educational projects

An in-depth analysis of foreign experience in the development and evaluation of educational programs in interaction with employers showed that the development of competencies and the achievement of learning outcomes in accordance with the requirements of employers varies from country to country and has a different degree of successful implementation. For this purpose, as one of the tools of the communication and information platform of international educational projects, a subsystem of designing educational programs was proposed, created for the development of educational programs in accordance with the requirements of

employers. The situation that has developed in the world with a pandemic, dictated by large-scale socio-economic conditions, requires an increase in the quality of the provision of educational services. In this context, the concept of "quality" is usually used in the case of compliance of a product or service with certain standards. In this case, the quality of education can be considered from the standpoint of:

- compliance with the mandatory standard of education;
- compliance with the requirements of consumers of educational services.

Consumers of educational services can be graduates of schools and colleges, as well as enterprises and organizations. At the same time, the educational process should be carried out in close cooperation with scientific centers. Thus, the interaction between the university and employers becomes an important indicator of the quality and reliability of the university's activities, one of the most important criteria for its competitiveness in the education market and the labor market.

Ukraine is currently modernizing its educational and professional standards, forming the appropriate legislative and regulatory framework, creating conditions for involvement in the processes of building a new innovative National System of Qualifications (NSQ) with the assistance of the European Education Fund (EEF) and interested parties (stakeholders). In accordance with the powers defined by the statute of the National Qualifications Agency, which was approved by the Resolution of the Cabinet of Ministers of Ukraine № 1029 dated 05.12.2018, the Agency supports the introduction of the National Qualifications Framework in compliance with the requirements of the Law of Ukraine "On Education"; carries out international cooperation in the field of qualifications, in particular with the aim of harmonizing the National Framework of Qualifications with relevant international documents; provides support for the information provision of the National System of Qualifications and the National Framework of Qualifications, etc.

Thus, it is the National Framework of Qualifications (NFQ) that acts as one of those fundamental tools that ensure the comprehensibility and comparability of educational systems [50].

The National Framework of Qualifications contains 8 qualification levels, which

corresponds to the European Qualifications Framework and education levels [51]. The eight recommended levels are described in the form of learning outcomes and indicate that the qualification represents, in various combinations, the full range of educational outcomes, including theoretical knowledge, practical and technical skills, as well as social competence, for which the ability to cooperate with other people is crucial. The NFQ is aimed at ensuring cross-industry compatibility of the formed competences for the purpose of assigning relevant qualifications and can be used for:

- development of professional standards and industry frameworks of qualifications (SFQ);
- formulation of uniform requirements for learning outcomes at all levels of professional education in order to ensure continuity of education and continuity of educational programs;
- development of a methodology for evaluating the qualifications of graduates at all levels of education.

Thus, the National Qualifications Framework of Ukraine is a tool for combining the spheres of work and education and is a generalized description of the qualification levels recognized at the national level and the main ways of their achievement on the territory of Ukraine.

The NFQ levels are clearly distinct from each other and coordinated with all relevant stakeholders, including education service providers (educational institutions), learners, workers and end users (employers). The NFQ is a general guideline and may differ significantly from the situation in specific industries (areas of professional activity). SFQs are developed taking into account the national framework of qualifications in a specific field of economic activity. The introduction of SFQ reflects the peculiarities of the application of NFQ to each specific industry. At the same time, not all levels of the NFQ may be involved, and in the SFQ itself there may be professional sub-levels or changes in the description of some competencies, knowledge and skills at different levels [52]. With the aim of a systematic and structured description of labor functions, as well as tasks related to their implementation, which regulate the requirements for knowledge, abilities, skills and competencies of

specialists, professional standards (PS) are developed based on the qualification requirements of the SFQ. The professional standard is a multifunctional regulatory document and defines the requirements for content, quality and working conditions, the level of qualification and competence of a specialist for a specific field of professional activity. [50].

The professional standard is used in the development of internal regulatory documents of the organization regarding the establishment of norms of labor activity of employees, determination of their job duties, plans for professional development, the procedure for certification of a person, and others. Professional standards are updated in accordance with changes in the conditions of professional activity, which are based on the modernization and change of production technologies, the aging of the existing competencies of specialists and the emergence of new professions. Professional standards are intended for:

- development of uniform requirements regarding the content of professional activity, updating of qualification requirements that meet the modern needs of the labor market;
- solving a wide range of tasks in the field of personnel management;
- development of educational standards, curricula, modular training programs, as well as development of relevant educational and methodological materials;
- assessment of professional training and confirmation of compliance of specialists qualifications. Professional standards are a basic document when designing modular training programs.

In the case of implementation of the competence approach, the composition of competences/learning outcomes is determined by:

- employers who set requirements for a university graduate based on a fairly large number of factors affecting the quality implementation of production programs;
- teachers who lead certain disciplines included in the module, which forms this or that competence on the basis of his competence, work experience, his creative and innovative activity, which is reflected in the development and introduction of elements of new content of education and original pedagogical technologies that allow to

improve the quality of education in higher education;

- and other stakeholders, which may include industry associations, scientific and other organizations.

The qualitative composition of competencies will be determined by employers, teachers and other stakeholders both from the standpoint of theoretical training and with a practice-oriented component, as well as taking into account changes in modern production, its technical and technological rearmament in the relevant field. One of the tools for implementing the competency-based approach in the professional education system is competency-oriented educational programs that allow for the formation of competencies that meet the modern requirements of the labor market with the help of modular training.

The implementation of modular programs aimed at gradually improving the quality of the training process based on the regulation of employers' requirements for the quality of educational services will allow Ukrainian educational institutions to improve the quality of training specialists with the help of educational programs focused on a specific result and become an active participant in the labor market. Thus, the development and implementation of competency-oriented modular programs in organizations of higher and post-secondary education will allow to create a balance between the content of EP formed by competencies and the need of the labor market for specialists who have certain qualifications, and the involvement of scientific organizations in the process will allow to train personnel and modernization of enterprises in accordance with the latest scientific achievements. In this situation, the competence approach can be considered as an effective tool for updating and optimizing the content of education.

The need to develop competence-oriented educational programs is caused by: changes in the structure of demand and requirements for the qualifications of specialists; - the need to update educational programs of professional education in accordance with the modernization and automation of production; - changing the requirements for the personal and professional competencies of specialists; - the emergence of fundamentally new professions at the intersection of industries, which require the

formation of innovative competencies.

4.2. Subsystem of analysis of educational programs

Competency-oriented educational program (COEP) in the system of higher education is developed for the training profile within the specialty in accordance with the current Classifier of Educational Specialties of Ukraine. The competency-oriented educational program has a modular format. The analysis of the competence-oriented educational program is carried out in the following sequence (fig.):

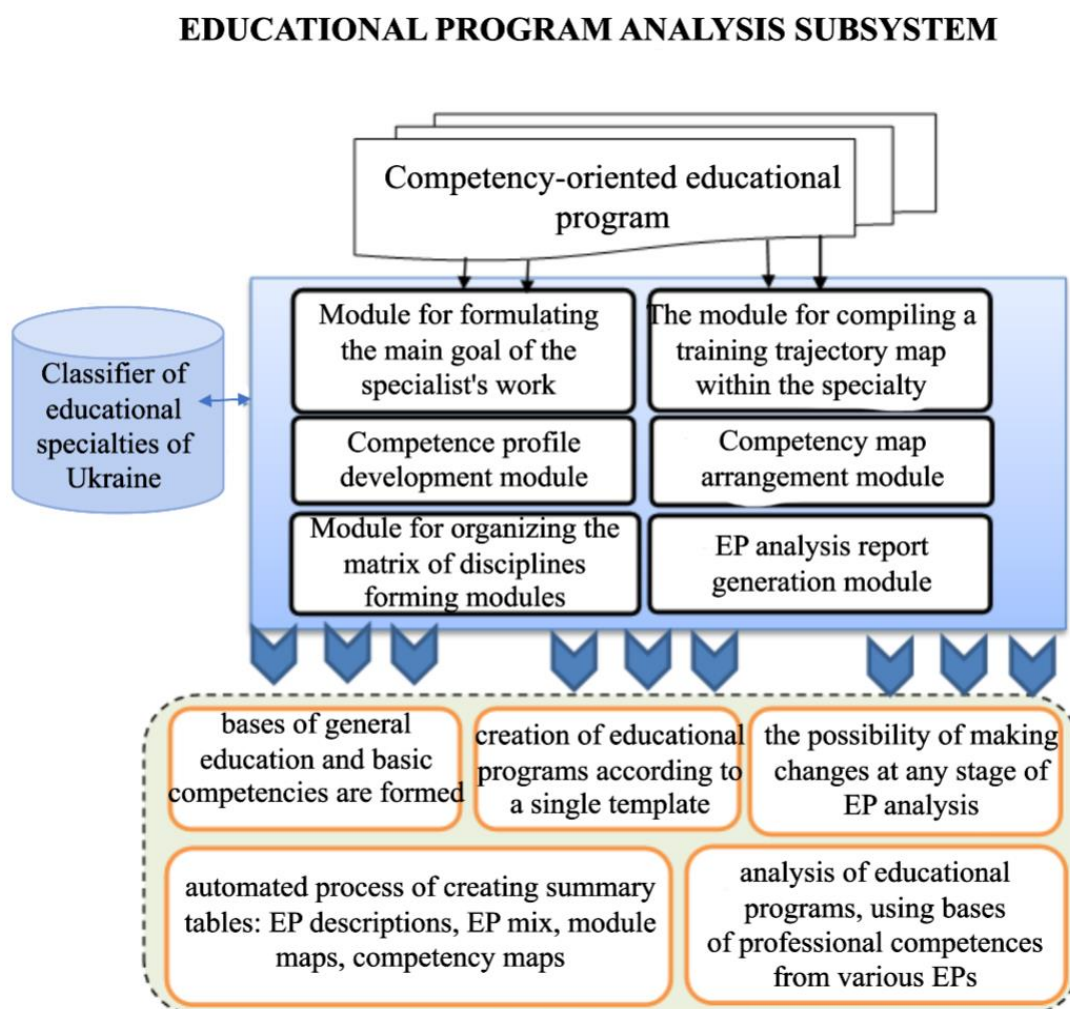


Fig. 4.2. Scheme of the subsystem of the analysis of educational programs

To automate the mentioned processes, the Educational Program Analysis System (SA EP) was developed, which is specialized software designed for the analysis of

educational programs of higher education as a designer. The educational program analysis system is intended for specialists who conduct EP analysis and is a mechanism for higher education EP analysis based on unique ready-made software.

The implementation of the EP analysis precedent can be presented in the form of a diagram of types of activities, which presents the key points of the implementation of the educational program design process (Fig. 4.3).

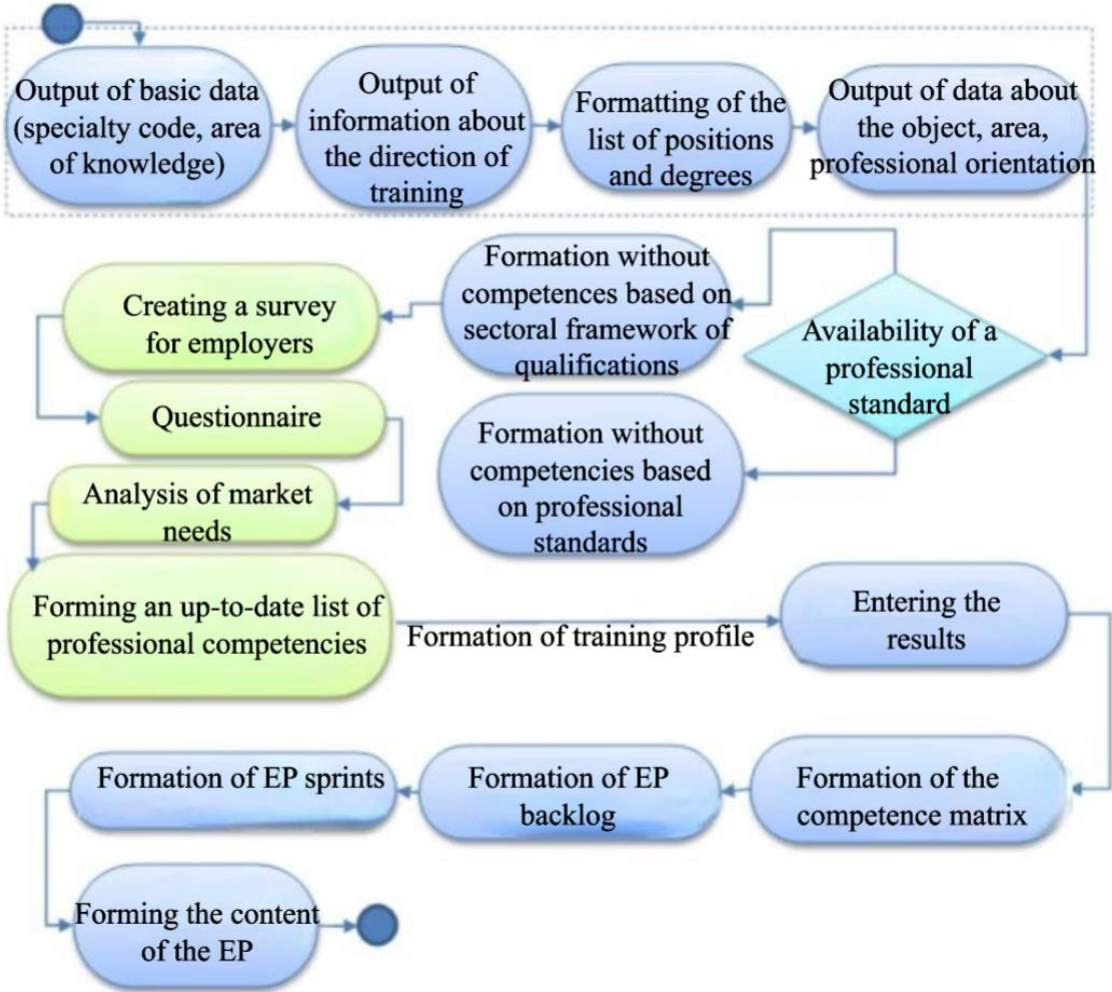


Fig. 4.3. Diagram of the types of activities of the EP Analysis precedent

To start work, it is necessary to open the start page of SA EP. When clicking the "Get started" button, users are offered a registration form. To register, you must enter a unique login in Latin, an email address and a password containing at least 6 characters. A registered user starts work from the "Log in" option in the upper right

corner of the screen. After that, the login form opens. To gain access to sections of the design system, you must use the user's Personal Account.

You can work in the following directions in your personal office.

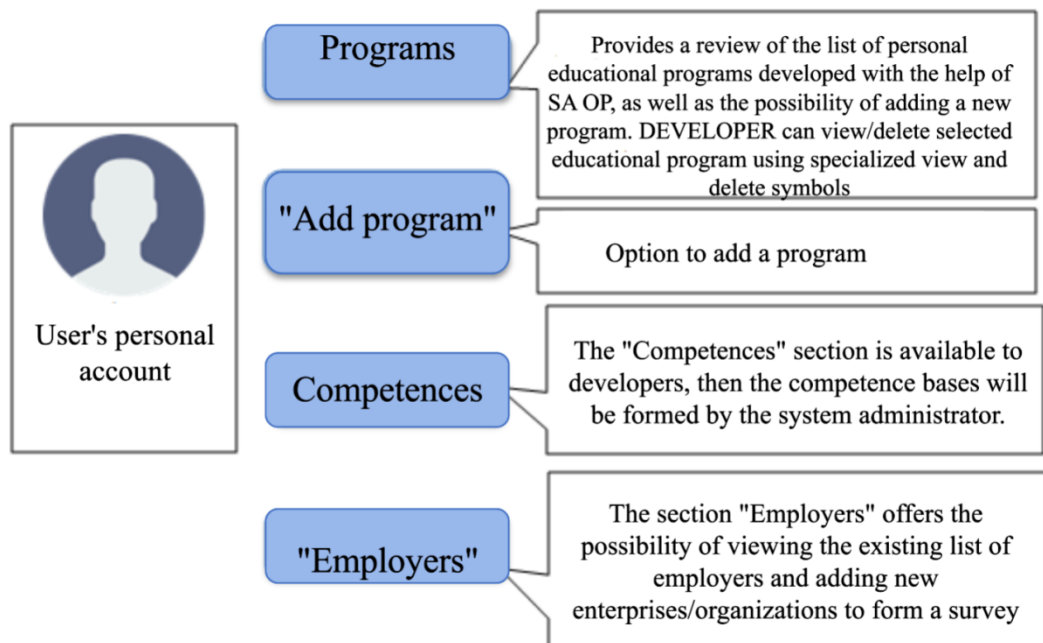
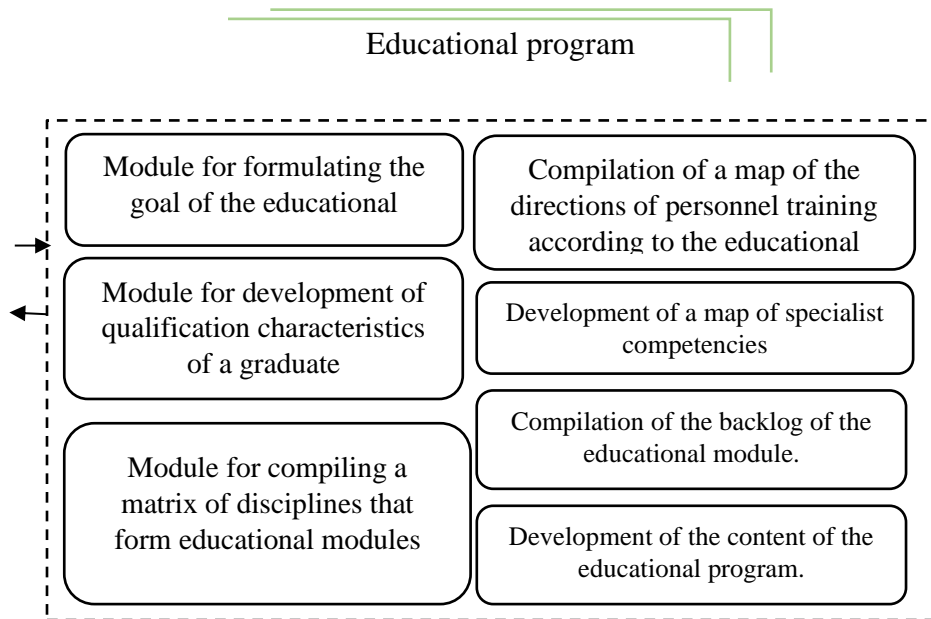


Fig. 4.4. Options of the user's personal account of the educational program analysis subsystem

The educational program has a modular format and its design is carried out in the following sequence: 1. Formulation of the goal of the educational program. 2. Compilation of a map of personnel training directions according to the educational program. 3. Development of qualification characteristics of a graduate 4. Development of a map of specialist competencies. 5. Compilation of the matrix of disciplines forming educational modules. 6. Drawing up a map of the educational module. 7. Development of the content of the educational program.



Classifier of educational specialties of Ukraine

Fig. 4.5. Scheme of the "Educational Program" module

The educational program design algorithm is presented in fig. 4.6.

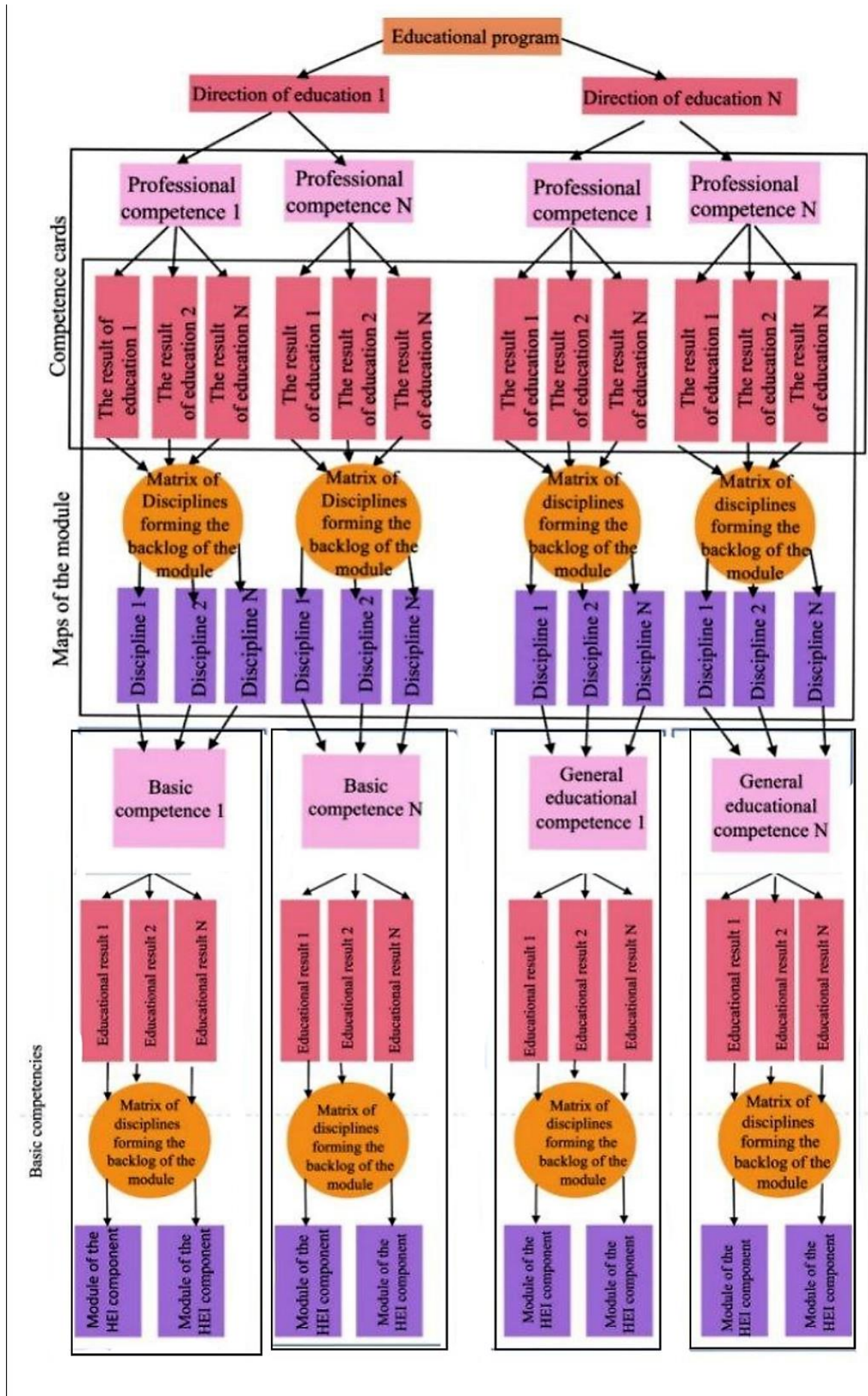


Fig. 4.6. Algorithm for designing the content of the EP

When designing EP in the proposed system, it is necessary to perform the following sequence of steps: 1. Filling out Form 1: Description of the educational program. After filling in the preliminary data, the user goes to the Passport of the educational program. The goal of the educational program is formulated taking into account the main goal of the activity carried out by the specialist. Therefore, first of all, the main goal of the activity carried out by the specialist is formulated - a description of the action or actions necessary to achieve the result. Then the object of the action is described, if there is a need, the situation of the action is described. The main goal of the activity carried out by the specialist should be measured and observed and briefly describe the professional area as the total result of what should be achieved in this area of training. Based on the main goal of the activity carried out by the specialist, the goal of the educational program is formulated. The purpose of the educational program is formulated as: "Training of specialists for the implementation of... (according to the main purpose of the activities performed by the specialist). Next, a Map of the direction of personnel training according to the educational program is drawn up in accordance with the Classifier of personnel training directions. The developer can choose either the current classifier or the 2021 classifier.

Qualification characteristics of a graduate consist of the following components: Awarded degree; List of specialist positions; Field of professional activity; Object of professional activity; Types of professional activity; Functions of professional activity. After filling out all the forms, click the "Add" button. After adding the form, the developer automatically goes to the page with the list of educational programs and selects the appropriate program for work. To enter the program, you need to use a specialized viewing sign (Fig. 4.7.)

Program list

Showing 1-10 of 10 entries

№	Code and name of the educational program	Код	
1	Project management	634562	  
2	Enterprise management	634563	  
3	Project management in the field of information technologies	634564	  
4	Enterprise management	634565	  
5	Business Economics	634566	

Fig. 4.7. List of educational programs of the developer

Next, the SA EP offers to enter the elements necessary to complete the educational program. In the upper part of the form there is a working panel containing buttons for downloading the generated documents. A key element in designing an educational program is the formulation of competencies. The normative starting point is the Professional Standard [53]. The projection of the professional standard (if available) on the educational program is presented in fig. 4.8. If there is no Professional Standard for a given profession at the moment, it is necessary to actively involve employers and other stakeholders in the development of a map of professional competences, which can be represented by industry associations, scientific and other organizations, so that the composition of the PC is determined taking into account the current trends in the development of the field of professional activity a graduate of this educational program.

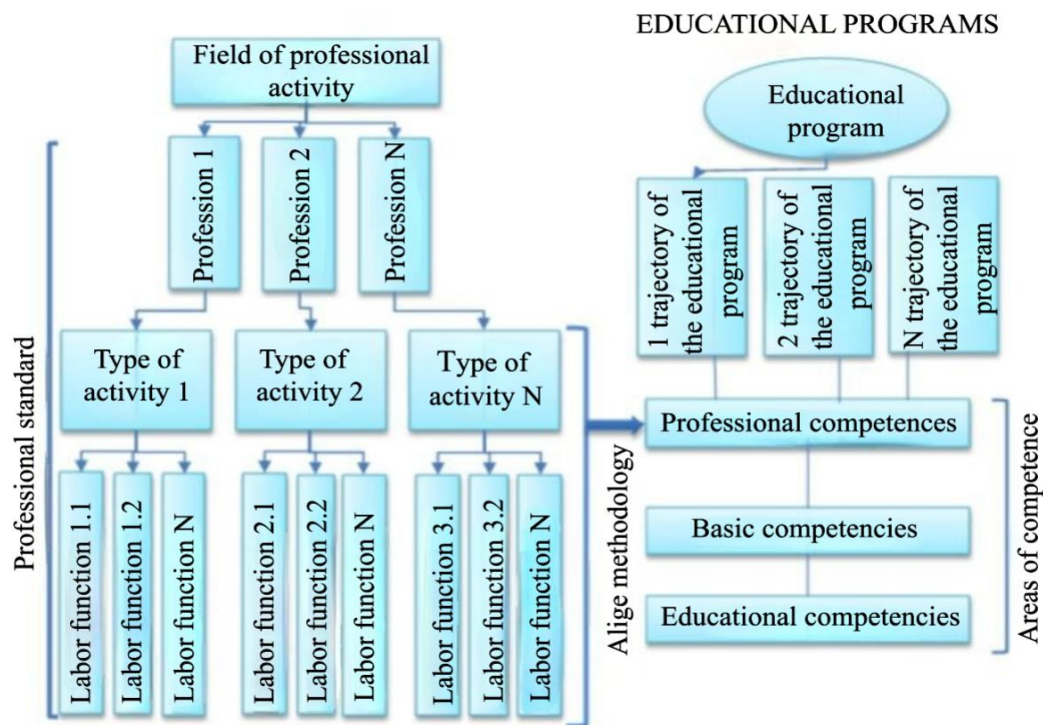


Fig. 4.8. Projection of the professional standard on the educational program

In the test version of the developer role program, there is an opportunity to add competence yourself. Later, lists of competencies will be generated automatically. To add a competence, you need to select the item "Add competences" in your personal account. After pressing the "Add" button, it is necessary to return to Form 2 through the list of programs (Fig. 4.9).

Home / Educational programs / Project management

Download specialty passport Download the profile card CP1

Code	634562
The name of the educational program	Project management
Manager	Chaluj Igor_EPAM

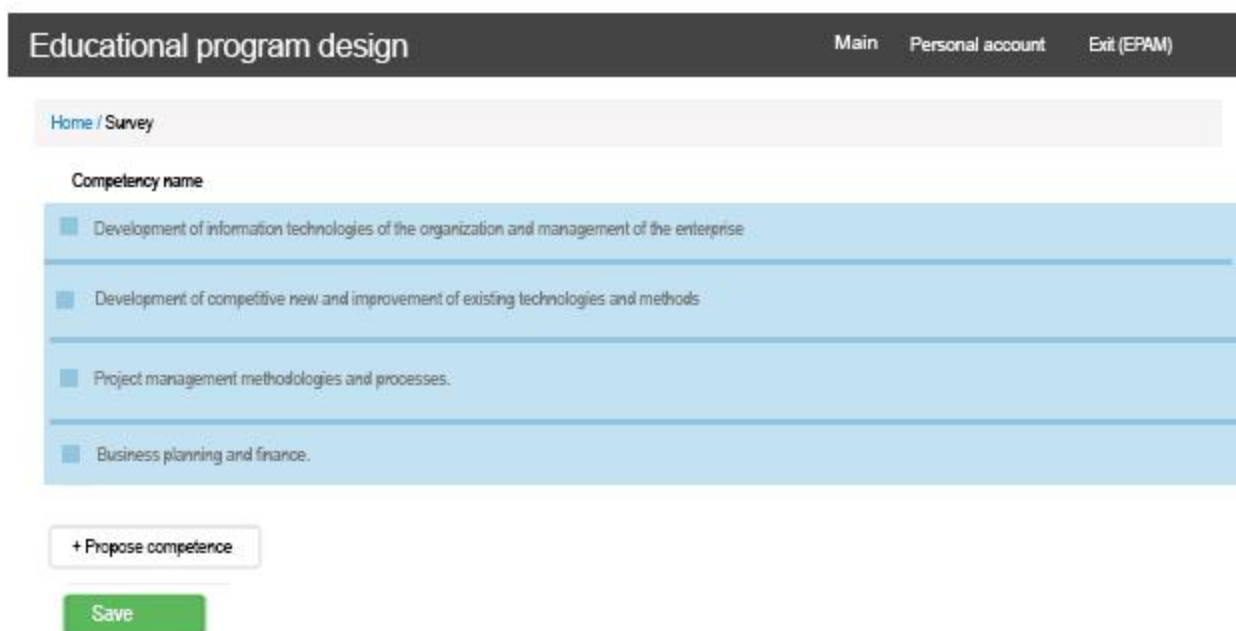
Professional competences

Entries 1-10 of 10

Назва компетенції	
Development of information technologies of the organization and management of the enterprise	
Development of competitive new and improvement of existing technologies and methods	
Project management methodologies and processes. Automation of project management processes	
Business planning and finance.	

Fig. 4.9. List of professional competencies

Form 2 shows completed tables for each type of competence. At this stage, the developer has the option of sending the base of professional competencies to one or more employers to form the final list of PCs. We add the employer or select the required employer from the list, attach the educational program to it and send the generated unique link to the employer's email. The employer follows the link and selects the required competencies from the list or offers his/her own competency using the "Offer competencies" command (Fig. 4.10).



The screenshot displays a web interface for 'Educational program design'. At the top, there is a dark navigation bar with the title 'Educational program design' and links for 'Main', 'Personal account', and 'Exit (EPAM)'. Below this is a breadcrumb trail 'Home / Survey'. The main content area is titled 'Competency name' and contains a list of four competencies, each with a blue square icon to its left:

- Development of information technologies of the organization and management of the enterprise
- Development of competitive new and improvement of existing technologies and methods
- Project management methodologies and processes.
- Business planning and finance.

Below the list, there is a button labeled '+ Propose competence' and a green 'Save' button.

Fig. 4.10. Questionnaire of the employer

The result of these operations is the appearance in Form 2 of the list of professional competencies proposed by the employer. To add the proposed competencies to the general list, click the "Move to competency" button, and then start filling in the learning outcomes. In addition, the developer has the opportunity to view the competencies most in demand by the employer in the "Employer's Mark" column, where the numerical expression of the survey results is displayed (Fig. 4.11).

Competences from employers

Showing entries 1-1 of 1

<input checked="" type="checkbox"/>	Competency name	Employer
<input checked="" type="checkbox"/>	Proposed competence No. 3 (Forec...	EPAM Systems

Add to competence

Professional competences

Showing entries 1-12 of 12

Competency name	Note of the employer	
Integration of system, project, process and scenario approaches in project management	3	
Project management methodology in a dynamic environment	1	
Development of project management based on the technological maturity model	1	
Management of innovative platforms of the organization's projects	1	
Portfolio oriented management	2	
Proposed competence No. 1 (Business – management processes of projects, programs and portfolios of the organization)	1	
Proposed competence No. 2 (Methodology of project management for the creation of information technologies (ISO 12207, CMMI, RUP))	2	

Fig. 4.11. Display of survey results

Adding disciplines is implemented using the "Add a discipline" tool, the type of discipline is selected from the list. After adding all disciplines, you need to use the "Create" button. The next step is to add learning outcomes. To do this, you need to use the viewing tool in the right column of the competence table. Form 3: Matrix of competencies. At the same time, a separate matrix is provided for each competence (Figure 4.12).

Name of the educational module

IT project management

Action	The results education / Disciplines	Theory systems and adoption solutions	IT project management	Management teams	Management risks	Economic mathematical methods and models	Self-management	Design-oriented organization	Management team leadership	Information systems management	Planning and control project with v-m IT	Business English language	Psychology management
Remove	Critically make sense of choose and use necessary scientific, methodical and analytical tool kit	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remove	Design effective systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Remove	Design effective systems	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Save Download the form

Fig. 4.12. Matrix of competences

To add learning outcomes, you need to use the "Add learning outcomes" tool. After the list of learning outcomes appears in the matrix, use the mouse to mark the cells of the disciplines within which each learning outcome is formed. The next step is to enter the name of the module and save the form. The name of the module is determined according to the profile of the competence and can be written as a verbal noun of the active verb of the corresponding competence or formulated according to the content of the competence. An additional possibility of the system is filling out forms for downloading thematic plans of disciplines. At the same time, it is possible to add topics from the discipline only for those specified in the learning outcomes matrix. Next, you need to enter data on each topic in the form. In this, it is necessary to indicate the means of assessment of each learning result, and even the labor intensity by types of classes. After filling out the forms, it is possible to download two types of thematic plans of the discipline. The final document, available for download, is the content of the educational program, which is formed on the basis of all data. If the data is filled in completely, the system will leave empty cells in the final document. If the thematic plans are not filled out or incorrectly formed, then this will be marked in color in the final document. The possibility to download this form is available on the main page of working with the educational program.

4.3. Evaluation module of educational programs

In order to conduct internal monitoring of the Ministry of Education and Culture, to determine the educational programs most in demand by the labor market and to exclude from the educational system EPs that do not meet the modern needs of society; increasing the competitiveness of the EP requires the use of the EP evaluation system. During the last three years, the country's universities have developed many educational programs of specialties, which may differ in elective components. The diversity and substantive variation of educational programs complicates their compatibility and comparability, familiarization with their content for heads of higher education

institutions, the professor-teaching community, employers and other stakeholders. It is necessary to systematize educational programs, that is, to create an appropriate register of educational programs. Previously, due to the fact that educational programs of specialties had a single set of disciplines corresponding to a typical curriculum, there was no need for such a register. The register of educational programs is an information system that includes a list of educational programs developed by various teams of developers, divided into subdivisions, for use by educational organizations and individuals. The register of educational programs as an electronic resource allows you to automate the input, storage, search, and maintenance of the database of educational programs. The scope of the Register is aimed at using it as a system for monitoring educational programs and a tool for regulating the quality of educational institutions, as well as for making individual management decisions in the field of education. Experts can use the Register when analyzing educational programs of potential partners. Universities and academic communities use the Register to improve the quality of EPs and their compliance with professional standards. The formation of the Register is carried out in three stages, Fig. 4.13.

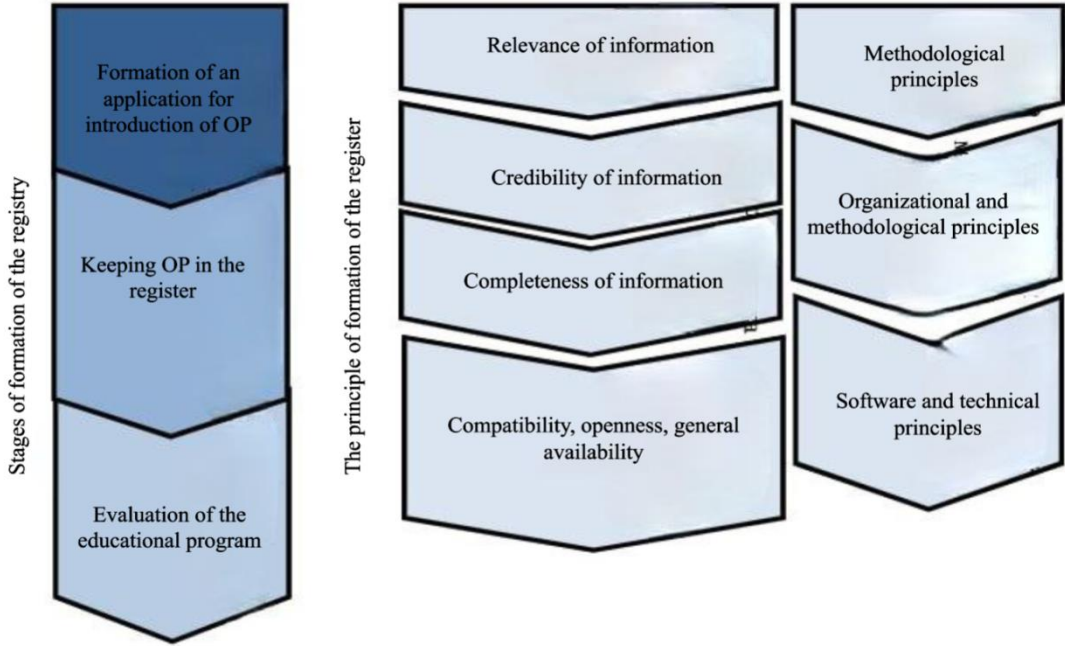


Fig. 4.13. Stages of formation of the Register and basic principles

Register of educational programs

English M Output

Home page

+ Add application

Search by the name of the educational program

Application type

Type of educational program: All

Status: All

Application submission date

Advanced search

Found records: 67

Name of the educational program	Type of educational program	Application type	Status	Date		
634553 Економіка підприємства	Current educational program	Entering EP in the register	Accepted	27.06.2020		
634554 Безпека інформаційних і комунікаційних систем	Current educational program	Entering EP in the register	Accepted	20.12.2020		
634555 Аналітика даних	Current educational program	Entering EP in the register	Accepted	19.06.2021		
634556 Комп'ютерні науки	Current educational program	Entering EP in the register	Accepted	25.03.2021		
634557 Маркетинг	Current educational program	Entering EP in the register	Accepted	04.07.2021		
634558 Менеджмент організацій	Current educational program	Entering EP in the register	Accepted	13.11.2021		
634559 Інженерія програмного забезпечення	Current educational program	Entering EP in the register	Accepted	05.06.2021		
634560 Прикладне програмування	Current educational program	Entering EP in the register	Accepted	08.10.2021		
634561 Кібербезпека	Current educational program	Entering EP in the register	Accepted	30.13.2021		
634562 Управління проектами	Current educational program	Entering EP in the register	Accepted	12.06.2020		
634563 Менеджмент в управлінні підприємством	Current educational program	Entering EP in the register	Accepted	23.09.201		

Fig. 4.13. User window for submitting applications to the Register

The rating of educational programs of Ukraine

English M

User panel

Group of educational programs: All

Year: All

Educational program: All

Status: All

Attainment: All

Subgroup	Group of educational programs	Educational program	Attainment	Year	Status
Cyber security	(125) Cyber security	634554 Information and communication security.		20.12.2020	Confirmed
Management	(073) Management	634562 Project management.		12.06.2020	Confirmed
Software engineering	(121) Software engineering	634559 Software engineering		05.06.2021	Confirmed
Комп'ютерні науки та ...	(122) Computer and information sciences...	634560 Applied programming		08.10.2021	Confirmed
Computer and informa...	(122) Computer Science	634556 Computer Science		25.03.2021	Confirmed
System analysis	(124) System analysis	634555 Data analytics		19.06.2021	Confirmed
Economics	(051) Economics	634553 Enterprise economy		27.06.2020	Confirmed
Management	(073) Management	634558 Management of Organizations		13.11.2021	Confirmed
Marketing	(075) Marketing	634557 Marketing		04.07.2021	Confirmed
Management	(073) Management	634563 Management in enterprise management		23.09.201	Confirmed
Cyber security	(125) Cyber security	634561 Cyber security		30.13.2021	Confirmed

Show all

Fig. 4.14. Educational programs rating window

Specialty 634562 Project management

Educational program (year) 2020

Output 2020

The period of data collection 15.04.2021 21.09.2021

WARNING! MS Word or (.txt) file format

Development of an educational program with the participation of the association

The number of specialists involved in the educational process, involved in the relevant field

Demand for educational programs among applicants

Export to MS Excel

No data available

Participatory development *	Name of association (employer) *	Document title *	Recommendations of the employer *	Дата створення *	Document type *	Scan copy of document *
Private company	Samsung	PM_TPP of Ukraine		30-03-2020	PM educational program	PM_educa_program_p.pdf
Private company	Epam	PM_Epam		22-05-2020	PM educational program	PM_Te_p_p_Epam2020.pdf
Private company	Toyota	PM_Toyota		02-03-2020	PM educational program	PM_Toyota_e_p_p_2020.pdf
Private company	Cisco	PM_Cisco		26-01-2020	PM educational program	PM_C_pp.pdf

Fig. 4.15. Confirming documents in the OP Registry system

The methodology of designing and evaluating undergraduate educational programs with the participation of stakeholders, as well as its program support, was developed with the aim of creating an effective toolkit for unifying the forms and methods of designing and evaluating educational programs for the formation of a reference educational institution and the selection of potential partners among international educational institutions. It is assumed that the system of designing educational programs and the Register of educational programs will become the main tool for regulating the quality of EPs with the aim of their compliance with the demands of the labor market and the level of modern production. The methodology of designing educational programs is aimed at developing an educational program taking into account the requirements of professional standards and employers' proposals. The basis of the methodology is the transition from the well-known paradigm of the formation of professional competence of specialists, which was acquired by them after graduating from a professional educational institution in the conditions of production, to a competence-oriented paradigm, when the formation of professional competence is

carried out directly within the walls of the educational institution. Here, when interacting with stakeholders (in particular, employers) based on the competence approach, a system-forming factor of the learning process is created - the structure of learning outcomes. Learning outcomes are formulated in the form of acquired knowledge and skills, which are expressed in the form of professional, basic and general educational competencies, i.e. descriptions of what the graduate will know and be able to do after graduation. The proposed educational program design system provides an opportunity to automate the EP development process taking into account the needs of the labor market in accordance with the National Framework of Qualifications and Professional Standards. In order to achieve positive results of the EP implementation, it is necessary to constantly monitor the process of its development to update the EP, taking into account changes in the relevant subject areas, as well as to evaluate the final result - the quality of specialist training.

4.4. Implementation of the educational project management software module using the Scram

The information model of the module is SharePoint lists, in their origin, they are similar to tables in a database. Module data is stored in three main lists: "Tasks", "Users" and "Sprints". The conceptual model of the subject area is shown in Figure 4.16

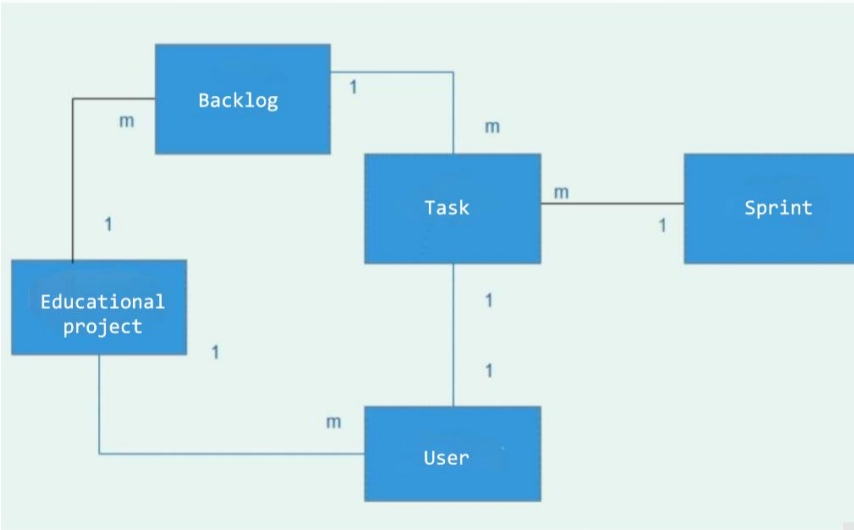


Fig. 4.16. Conceptual model of the educational project management module

based on the Scram methodology

The physical model of the subject area is shown in Figure 4.17.

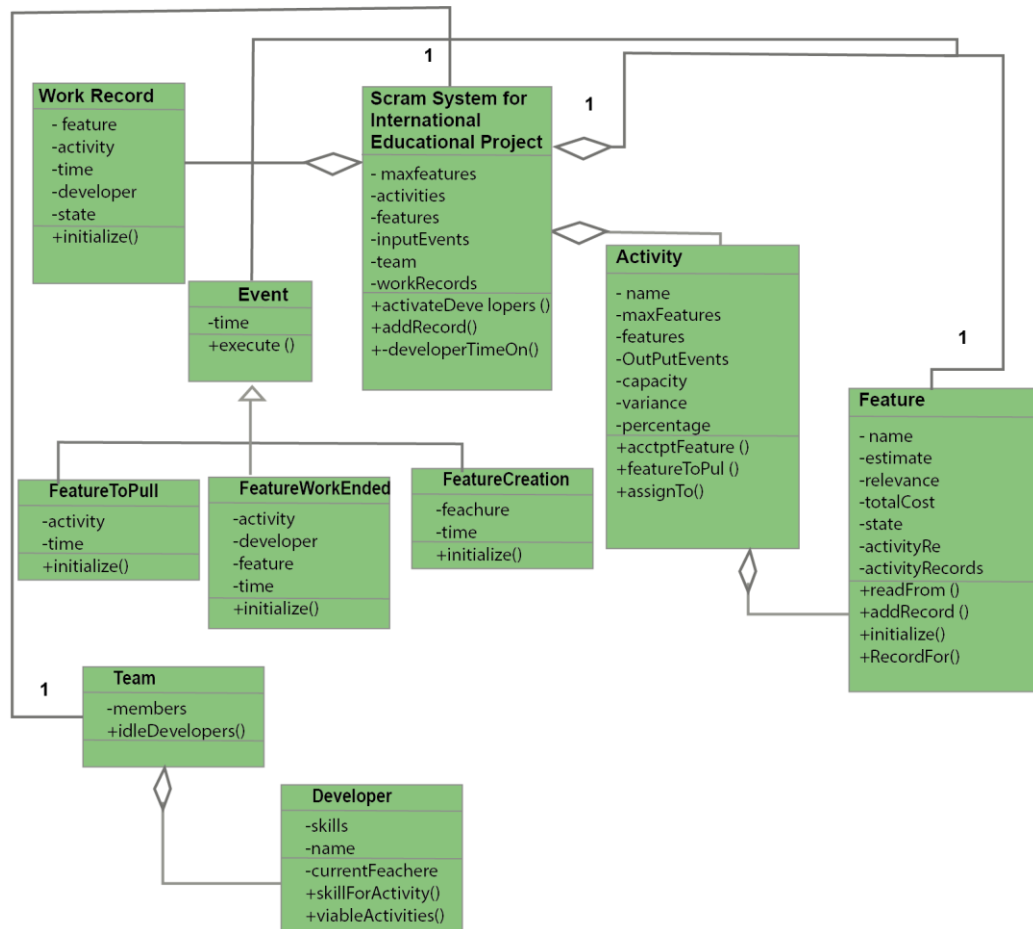


Fig. 4.17. Physical model of the educational project management module based on the Scram methodology

Module functionality is described using a functional model that reflects system precedents and the system environment.

The actors in the module are 3 actors: the project manager, the scrum master and the developer. After analyzing the connections between actors and precedents, we get the diagram of precedents shown in Figure 4.18.

The functional model contains 7 precedents.

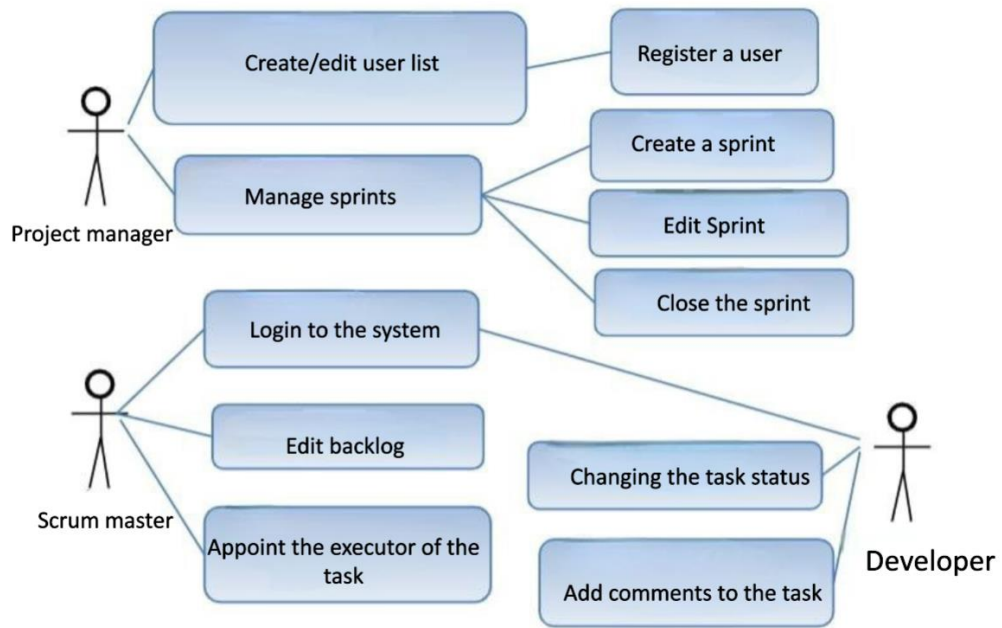


Fig. 4.18. Chart of precedents

The main process in the software module is the task execution process. (Figure 4.19).

The architecture of the module provides the project manager with the ability to create a new task and add it to the list of tasks.

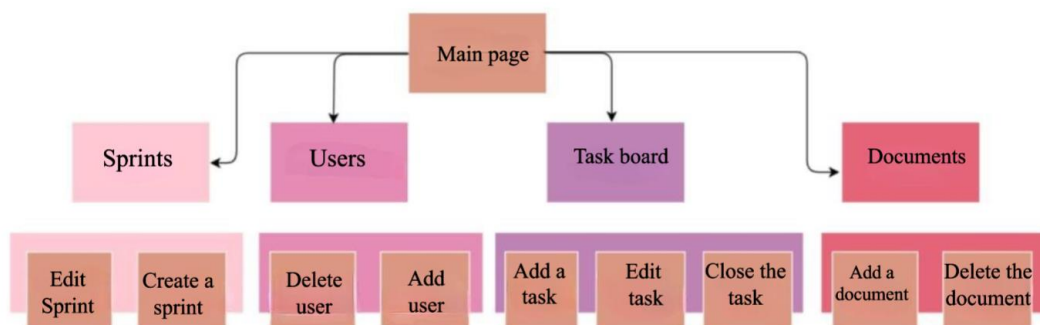


Fig. 4.20. The structure of the site, which reflects the implementation of the module

The Scrum Master of the team appoints a developer who will perform this task and sets the latest status to "TO DO". After that, the executor takes the task into work

(In Progress) and gets access to its status. Once a task is in Review status, it goes to the Scrum Master for review, who either changes it to Done (if completed) or In Progress with a description of the issues that need to be fixed, and gets it back to the executor.

Conclusions to section 4.

The proposed information technology was configured and used for the needs of the implementation of an international educational project within the framework of substantiation of partner benchmarking models and the marketing complex of this educational institution. The methodological and analytical approach and ICT on the well-founded Agile platform, introduced by the author, were applied to solve the problems of marketing planning of the graduation program and sales forecast of educational services at the international level. Information and analytical results studies adapted to the IEC-PAM work cycle allow this university to use benchmarking as:

- diagnostic tools (including comparative quality of educational services);
- a tool for determining the directions of self-improvement;
- a training method for improving the activity of an educational institution, identifying "problem areas", searching for a model of a "reference institution" from the standpoint of the project's content and the requirements of the Agile platform.

For the needs of the IEC-PAM international project, an integrated communication and information environment based on the following operating subsystems has been substantiated: subsystem of educational program analysis; a subsystem for the administration and adjustment of educational projects and a program based on sound methodologies of the Scrum approach. It is necessary to develop the specified information and communication environment within the framework of the author's approach, to develop variants of the IEC-PAM cycle, then to present project alternatives for consideration by the management, and to implement the chosen alternative in the following stages:

- prerequisites (image-management, resource-logistics, personnel-competence and institutional) implementation of strategic transformations of the university with its adjustment to the tasks of the IEC-PAM international project;
- the stage of the pre-start project - initial initiation and preparation of the project

for its implementation on the Agile platform;

- formation of the environment of project stakeholders and the format of the project office;
- implementation and operational adjustment of the cycle;
- provision of local and integral results (values and software products) of the project.

As evidenced by the scientific-applied research results of the provision of a content-process and transformational paradigm for the management of international educational, educational-informational and information-productive projects, which subsequently contribute to the sustainable development of educational environments and ensure the growth of the target functional quality for the course of the educational and scientific process in higher educational institutions.

GENERAL CONCLUSIONS

The main conclusions and results of the conducted research should include the following:

1. A critical analysis of the content of basic definitions and theoretical principles regarding the possibilities of using modern information, information and communication technologies for use in educational processes, in particular in international educational processes, was carried out. The essential advantages of using the Agile platform for the needs of training, administration and improvement of educational, preparatory, communicative and logistical processes within the framework of the specified projects are highlighted. A significant advantage of the application of the Agile platform to the administration of international educational projects is the ability to combine: the advanced values of "software development", the values of an international project, the possibilities of extreme Scrum programming, DSDM, FDD, in addition to the application of the Agile platform within the framework of the administration of the IECP-PAM cycle "international educational and communication project on the platform of Agile methodology" (abbreviation of "International Educational and Communication Project on the Platform of Agile Methodology") ensures proper minimization of objective and subjective risks of the

project through the use of iterations of "mini-cycles". In each such mini-cycle, the functional requirements of the design and administration stages, the content and programming environment, the expected format of testing and documentation, the outline of the expected software product, and the priorities that dynamically change from the previous iteration to the next are adequately described in a special informational vocabulary.

2. The broad possibilities of using ICT in the Agile digital environment for structuring the goals of tasks, milestones and stages of international projects are substantiated. The Agile platform is based on direct communication between IECP-PAM subjects in a special bullpen office, which allows for successful interaction between institutional subjects of the project (from different universities), performing subjects, managers and clients. The strategy of such an office is to use the Agile methodology to structure the overall cycle into mini-cycles of local software products. Local and integrated software products in the Agile environment act as a digital analogue of the project's technical documentation.

3. The basic principles for the primary organization of decisions on coordinating the environment and activities of participants in international projects using ICT & Agile are defined. The priority principles are: the primacy of the general vision of the content and target direction of the IECP-PAM type project; a clear understanding of the communication regulations between project subjects, the flow of resources in the middle of the project's operational system; ensuring successful prioritization of the task list; achieving a rational compromise between the complexity of the development and the "value of the user story"; improving the quality and reducing the duration of feedback.

4. In order to direct the successful direction of the Agile methodology to the implementation of the tasks of the IECP-PAM cycle, the studied Agile Modeling, Agile Data Method, DSDM, Essential Unified Process were combined with the following methodical components: function-oriented development (FDD), an iterative approach without functional specifications , (Getting Real), Scrum rules for managing development and coding processes, Software Development approaches,

methodological components of educational management and marketing, conceptual foundations of convergence theory, stakeholder theory, and project core values. This methodical foundation of the research ensures success: the use of Agile methodology in the preparation and implementation of the IECP-PAM cycle; communications of international project participants; creativity and innovative thinking of the project manager and executors. The specified components of the methodological basis allow to form a convenient information model for managing the IECP-PAM cycle through dynamically connected models of micro-cycles, and further to form the resulting software product for managing the content and values of the international educational process.

5. Agile was developed and substantiated - an adapted technology of administration and flexible adjustment of the content and characteristics of an international educational project. The format of the IECP-PAM cycle management information technology introduced in the study provides a formalized description and regulation of educational, logistical, communicative, management processes based on the author's formalized indicators of the project cycle. The built technology is based on the capabilities of the Scrum approach, which allows, without a clear division into formal internal specializations, to use diverse specialists who are divided into leading management roles: Scrum master (organizer) and Product owner. With the use of the author's system of indicators, the progress of the project cycle is assessed according to four universal coordinates:

a) productivity (regarding the performance of tasks at certain stages and stations of the IECP-PAM cycle);

b) quality (in the assessment of project stakeholders, time and resources spent on creating project products);

c) forecast (regarding the values of "user stories" within micro-cycles and their combinations)

d) business value and the visualized chain of "project value core dynamics"

6. The proposed information technology was configured and used for the needs of the implementation of an international educational project within the framework of

substantiation of partner benchmarking models and the marketing complex of this educational institution. The methodological and analytical approach and ICT on the well-founded Agile platform, introduced by the author, were applied to solve the problems of marketing planning of the graduation program and sales forecast of educational services at the international level. Information and analytical results studies adapted to the IEC-PAM work cycle allow this university to use benchmarking as:

- diagnostic tools (including comparative quality of educational services);
- a tool for determining the directions of self-improvement;
- a training method for improving the activity of an educational institution, identifying "problem areas", searching for a model of a "reference institution" from the standpoint of the project's content and the requirements of the Agile platform.

7. For the needs of the IEC-PAM international project, an integrated communication and information environment based on the following operating subsystems has been substantiated: subsystem of educational program analysis; a subsystem for the administration and adjustment of educational projects and a program based on sound methodologies of the Scrum approach. It is necessary to develop the specified information and communication environment within the framework of the author's approach, to develop variants of the IEC-PAM cycle, then to present project alternatives for consideration by the management, and to implement the chosen alternative in the following stages:

- prerequisites (image-management, resource-logistics, personnel-competence and institutional) implementation of strategic transformations of the university with its adjustment to the tasks of the IEC-PAM international project;
- the stage of the pre-start project - initial initiation and preparation of the project for its implementation on the Agile platform;
- formation of the environment of project stakeholders and the format of the project office;
- implementation and operational adjustment of the cycle;
- provision of local and integral results (values and software products) of the project.

As evidenced by the scientific-applied research results of the provision of a content-process and transformational paradigm for the management of international educational, educational-informational and information-productive projects, which subsequently contribute to the sustainable development of educational environments and ensure the growth of the target functional quality for the course of the educational and scientific process in higher educational institutions.

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APPENDIX A. ACTS OF IMPLEMENTATION



TEL 0086-575-83267001 ADDRESS: 8/F, SHENGZHOU CHAMBER OF COMMERCE BUILDING, ZHEJIANG PROVINCE

ACT OF IMPLEMENTATION

The act of implementing the results of the dissertation work of PhD student **Zhu Ting** «MODELS AND METHODS OF MANAGING JOINT UKRAINIAN-CHINESE INTERNATIONAL PROJECTS BASED ON AGILE METHODOLOGY»

THE ACT WAS DRAWN UP BY A DIRECTOR OF ZHEJIANG ACME INFORMATION TECHNOLOGY CO. LTD JIYONG YAN

ZHEJIANG ACME INFORMATION TECHNOLOGY CO. LTD considered in detail the results of **Zhu Ting** dissertation research, «Models and methods of managing joint Ukrainian-Chinese international projects based on Agile methodology» and established:

While writing his dissertation, **Zhu Ting** fruitfully cooperated with our company and implemented research results for several years.

1. The Commission believes that **Zhu Ting** dissertation reflects in his work the content-process and transformational paradigm of international project management, which is implemented through a mathematical model of strategic integration of international projects in the digital space, which allows rationalizing the trajectory of the movement of the subjects of such projects, minimizing time and resource costs.
2. The work uses the Agile platform for a formalized description of the information and digital space of subjects, phenomena, and products of international scientific and educational projects, which allows an adequate model of the course of the life cycle of such projects and provide timely assessments of the effectiveness of these projects for their institutional participants, the administration system and performers.
3. The author formed priorities for identifying digital strategic milestones of the international information and educational project, which will be taken into account by the temporary structure of the project administration. The specified temporary administrative structure with the use of formalized digital indicators makes it possible to choose from the presented options for the administration of the cycle of the international educational project the one that best corresponds to the strategy of "educational and scientific synergy," and at the same time, best meets the requests of the institutional subjects of the project.
4. In a practical sense, the work introduced a systematic approach, an analytical toolkit, and an information-application and communication environment in the AGILE format and application software products using FDD-graphics and Scrum of the digital space created on their basis made it possible to develop an integrated information-communication platform for initiating preparation and implementation of international educational and scientific projects.

We believe that the practical implementation of **Zhu Ting** research work in the practice of enterprise activity is an important reason to believe that **Zhu Ting** deserves to be awarded the scientific degree of Doctor of Philosophy in specialty 122 - "Computer Science".

Zhejiang ACME Information Technology Co. LTD JIYONG YAN

TEL 0086-575-83267001

ADDRESS: 8/F, SHENGZHOU CHAMBER OF
COMMERCE BUILDING, ZHEJIANG PROVINCE

11.05.2023



APPENDIX B. LIST OF THE APPLICANT'S PUBLICATIONS ON THE THEME OF THE DISSERTATION AND INFORMATION ON THE APPROVAL OF THE RESULTS OF THE DISSERTATION

Articles in professional publications of Ukraine

(included in the list of the Ministry of Education and Science of Ukraine)

1. **Zhu, Ting.** (2020). The application of Agile's flexible methodology in planning a joint international specialist training program. *Management of Development of Complex Systems*, 41, 156 – 162, dx.doi.org\10.32347/2412-9933.2020.41.156-162. [category «B»] <http://mdcs.knuba.edu.ua/article/view/203823>
2. **Zhu, Ting.** (2019). Technologies of organization of the communication process in educational projects and programs. *Management of Development of Complex Systems*, 37, 132 – 137, dx.doi.org\10.6084/m9.figshare.9783140. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-37/23.pdf>
3. **Zhu, Ting.** (2022). Methodology of partner benchmarking during the development of international joint educational projects based on Agile methodology. *Management of Development of Complex Systems*, 50, 93–101. dx.doi.org\10.32347/2412-9933.2022.50.93-101. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-50/93-101.pdf>
4. **Zhu, Ting.** (2022). Definition and evaluation of competitors in the development of international joint educational projects. *Management of Development of Complex Systems*, 51, 122–129. dx.doi.org\10.32347/2412-9933.2022.51.122-129. <http://urss.knuba.edu.ua/files/zbirnyk-51/122-129.pdf>

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1. **Zhu Ting.** (2020). Using the principles and approaches of flexible methodology (Agile) in the planning and implementation of the educational process. *Science Journal Innovation Technologies Transfer*. 48-55. 10.36381/iamsti.4.2020.48-55.

Approbation works

1. **Zhu Ting.** (2018). Strategy to increase the competitiveness of the university and its

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2. **Zhu Ting.** (2019). Organization of the communication process in education projects. «Управління проектами у розвитку суспільства», 63-64.

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2. **Zhu Ting.** (2020). Agile при плануванні спільної міжнародної програми навчання. *Seventh international scientific-practical conference «Management of the development of technologies» Topic: "Information technology development of educational content» Kyiv, 25 – 26 March 2020, 145-146.*

Appendix C. Interaction of systems of competitors, consumers and costs in the strategy of HEI



Appendix D. The minimum amount of tuition fees under the contract (indicative cost) of persons enrolled for higher education in 2020 by specialty

№ з/п	The name of the higher education institution (a separate structural subdivision of the higher education institution)	Region (Autonomous Republic of Crimea, including Kyiv, Sevastopol)	the minimum fee for 1 year of contract study for full-time higher education** that an institution of higher education can set for persons enrolled in 2020 to obtain a degree:			information for calculating the minimum fee for 1 year of study under a contract for a full-time education visa, which a higher education institution can set for persons enrolled in 2020		
			JUNIOR BACHELOR	BACHELOR (master's degree in medical, pharmaceutical, veterinary field)	MASTER	60% of the indicative cost price	100% of the indicative cost price	3 average monthly wages of full-time employees in 2019 in the region (Autonomous Republic of Crimea, e.g. Kyiv, Sevastopol) by the location of the higher education institution for the previous calendar year according to the State Statistics Service
1	Azov Maritime Institute "OMA"	Donetsk region	11 523	12 803	16 644	12 803	21 339	26 026
2	Berdvansk State Pedagogical University	Zaporizhzhia region	12 679	14 087	18 314	14 087	23 479	31 440
3	Berezhn Agricultural College of the National University of Biosources	Ternopil region	9 528	10 587	-	10 587	17 645	24 825
4	BeLOTS'K National Agrarian University	Kyiv region	9 545	10 606	13 787	10 606	17 676	33 009
5	Burshhtyn Energy College of Ivano-Frankivsk National Technical University	Ivano-Frankivsk region	13 786	15 318	-	15 318	25 530	26 451
6	Vinnitsia State Pedagogical University named after Mykhailo Kotsyubynskyi	Vinnitsia region	13 007	14 452	18 787	14 452	24 086	27 897
7	Vinnitsia National Agrarian University	Vinnitsia region	14 050	15 611	20 294	15 611	26 018	27 897
8	Vinnitsia National Technical University	Vinnitsia region	15 406	17 117	22 253	17 117	28 529	27 897
9	Vinnitsia Trade and Economic Institute KNUITE	Vinnitsia region	18 754	20 837	27 089	20 837	34 729	27 897
10	VP NUBIP of Ukraine "Berezhn Agrotechnical University"	Ternopil region	12 260	13 622	17 709	13 622	22 704	24 825
11	VP NUBIP of Ukraine "Nizhyn Agrotechnical University"	Chernihiv region	15 720	17 467	22 707	17 467	29 112	24 818
12	Hlukhiv National Pedagogical University named after Oleksandr Dovzhenko	Sumy region	15 314	17 015	22 120	17 015	28 359	25 737
13	Horliv Institute of Foreign Languages of the Donbas State Pedagogical University	Donetsk region	11 708	13 009	16 911	13 009	21 681	35 148
14	Horodyschen College of the Uman National University of Horticulture	Cherkasy region	9 522	10 580	-	10 580	17 633	26 514
15	SHEI "Prindiprovsk State Academy of Construction and Architecture"	Dnipropetrovsk region	20 278	22 531	29 290	22 531	37 551	32 253
16	SHEI "Ukrainian State Chemical and Technological University"	Dnipropetrovsk region	17 282	19 202	24 963	19 202	32 003	32 253
17	SHEI "National Forestry University of Ukraine"	Lviv region	20 714	23 016	27 813	23 016	38 360	27 813
18	SHEI "Donetsk National Technical University"	Donetsk region	12 712	14 125	18 362	14 125	23 541	35 148
19	SHEI "University of Banking"	m. Kyiv	16 872	18 746	24 370	18 746	31 244	47 328
20	SHEI "Donbas State Pedagogical University"	Donetsk region	16 468	18 299	23 788	18 299	30 498	35 148
21	SHEI "Vasyl Stefanyk Prykarpattia National University"	Ivano-Frankivsk region	12 337	13 708	17 820	13 708	22 846	26 451
22	State Higher Educational Institution "Uzhhorod National University"	Transcarpathian region	12 306	13 673	17 775	13 673	22 789	27 606
23	State University "Zhytomyr Polytechnic"	Zhytomyr region	10 310	11 455	14 892	11 455	19 092	25 584
24	State University of Economics and Technologies	Dnipropetrovsk region	16 006	17 784	23 120	17 784	29 640	32 253
25	State University of Infrastructure and Technologies	m. Kyiv	17 108	19 009	24 711	19 009	31 681	47 328
26	State University of Telecommunications	m. Kyiv	16 129	17 921	23 297	17 921	29 668	47 328
27	Luhansk National University named after Taras Shevchenko	Luhansk region	9 912	11 014	14 318	11 014	18 306	26 193
28	Dnipro State Agrarian and Economic University	Dnipropetrovsk region	9 919	10 577	13 750	10 577	17 628	32 253
29	Dnipro State Technical University	Dnipropetrovsk region	16 848	18 721	24 338	18 721	31 202	32 253
30	Dnipro National University of Railway Transport named after Academician Leonid Lyubchenko	Dnipropetrovsk region	16 407	18 229	23 698	18 229	30 382	32 253
31	Dnipro National University named after Oles Honchar	Dnipropetrovsk region	19 868	22 075	28 696	22 075	36 792	32 253
32	Donbas State Machine-Building Academy	Donetsk region	13 524	15 027	19 535	15 027	25 045	35 148
33	Donbas National Academy of Construction and Architecture	Donetsk region	14 732	16 369	21 280	16 369	27 282	35 148
34	Donetsk State University of Management	Donetsk region	17 610	19 567	25 437	19 567	32 611	35 148
35	Donetsk National University of Economics and Trade named after Mykhailo Hrushevskyi	Dnipropetrovsk region	16 023	17 803	23 144	17 803	29 672	32 253
36	Donetsk National University named after Vasyl Stus	Vinnitsia region	18 200	20 222	26 288	20 222	33 703	27 897
37	Ivan Franko Dorohobytzian National University	Lviv region	17 273	19 192	24 950	19 192	31 887	27 813
38	Zhytomyr Ivan Franko State University	Zhytomyr region	10 914	12 127	15 765	12 127	20 211	25 584
39	Zhytomyr National Agroecological University	Zhytomyr region	9 317	10 352	13 458	10 352	17 254	25 584
40	Zaporizhzhia National University	Zaporizhzhia region	16 383	18 204	23 665	18 204	30 339	31 440
41	Ivano-Frankivsk College of the Lviv National Agrarian University	Ivano-Frankivsk region	11 816	13 128	-	13 128	21 881	26 451
42	Ivano-Frankivsk College of Physical Education of the National University of Physical Education and Sport	Ivano-Frankivsk region	24 110	26 451	-	26 789	44 648	26 451
43	Ivano-Frankivsk National Technical University of Oil and Gas	Ivano-Frankivsk region	14 193	15 770	20 501	15 770	26 283	26 451
44	Izmail State Humanitarian University	Odesa region	15 579	17 310	22 503	17 310	28 850	27 738

No. of the	The name of the higher education institution (a separate structural subdivision of the higher education institution)	Region (Autonomous Republic of Crimea, including Kyiv, Sevastopol)	the minimum fee for 1 year of contract study for full-time higher education** that an institution of higher education can set for persons enrolled in 2020 to obtain a degree:			information for calculating the minimum fee for 1 year of study under a contract for a full-time education visa, which a higher education institution can set for persons enrolled in 2020		
			JUNIOR BACHELOR	BACHELOR <small>(master's degree in medical, pharmaceutical, veterinary field)</small>	MASTER	60% of the indicative cost price	100% of the indicative cost price	average monthly wages of full-time employees in 2019 in the region (Autonomous Republic of Crimea, e.g. Kyiv, Sevastopol) by the location of the higher education institution for the previous calendar year according to the State Statistics
45	Industrial College of the Ukrainian State Chemical and Technological	Dnipropetrovsk region	12 575	13 972	-	13 972	23 286	32 253
46	Kamianets-Podilskyi National University named after Ivan Ohienko	Khmelnitskyi region	12 712	14 124	18 362	14 124	23 541	26 016
47	Kyiv National University of Economics named after Vadym Hetman	m. Kyiv	18 349	20 387	26 504	20 387	33 979	47 328
48	Kyiv National Linguistic University	m. Kyiv	16 574	18 415	23 940	18 415	30 692	47 328
49	Kyiv National University of Trade and Economics	m. Kyiv	19 398	21 554	28 020	21 554	35 923	47 328
50	Kyiv National University of Construction and Architecture	m. Kyiv	15 414	17 126	22 264	17 126	28 544	47 328
51	Kyiv National University named after Taras Shevchenko	m. Kyiv	28 051	31 168	40 519	31 168	51 947	47 328
52	Kyiv National University of Culture and Arts	m. Kyiv	35 591	39 546	47 328	39 546	65 910	47 328
53	Kyiv National University of Technology and Design	m. Kyiv	16 017	17 797	23 136	17 797	29 692	47 328
54	Kremenchug National University named after Mykhailo Ostrogradskyi	Poltava region	14 291	15 879	20 642	15 879	26 454	29 538
55	Kryvyi Rih State Pedagogical University	Dnipropetrovsk region	12 713	14 125	18 363	14 125	23 542	32 253
56	Kryvyi Rih College of the National Aviation University	Dnipropetrovsk region	11 666	12 962	-	12 962	21 603	32 253
57	Kryvyi Rih National University	Dnipropetrovsk region	11 822	13 136	17 077	13 136	21 893	32 253
58	Luhansk National Agrarian University	Luhansk region	8 364	9 283	12 081	9 283	15 489	26 193
59	Lutsk National Technical University	Volyn region	9 486	10 540	13 782	10 540	17 596	25 889
60	Ivan Bobersky Lviv State University of Physical Culture	Lviv region	18 712	20 791	27 029	20 791	34 692	27 813
61	Lviv Institute of Economics and Tourism	Lviv region	25 400	27 813	27 813	26 222	47 037	27 813
62	Lviv National Agrarian University	Lviv region	16 616	18 463	24 001	18 463	30 771	27 813
63	Lviv National University of Veterinary Medicine and Biotechnology	Lviv region	12 205	13 561	17 629	13 561	22 601	27 813
64	Lviv Ivan Franko National University	Lviv region	13 787	15 319	19 914	15 319	25 531	27 813
65	Flight Academy of the National Aviation University	Kirovohrad Region	25 080	25 080	25 080	48 824	81 373	25 080
66	Mariupol State University	Donetsk region	17 254	19 171	24 922	19 171	31 951	35 148
67	Melitopol State Pedagogical University named after Bohdan Khmelnytskyi	Zaporizhzhia region	14 066	15 629	20 317	15 629	26 048	31 440
68	Mykolaiv National Agrarian University	Mykolayiv region	18 543	20 603	26 784	20 603	34 339	29 928
69	Mykolaiv National University named after V.O. Sukhomlynskyi	Mykolayiv region	14 571	16 190	21 047	16 190	26 983	29 928
70	Mukachevo State University	Transcarpathian region	18 975	21 083	27 408	21 083	35 139	27 606
71	National Metallurgical Academy of Ukraine	Dnipropetrovsk region	18 274	20 305	26 396	20 305	33 641	32 253
72	National Aviation University	m. Kyiv	17 951	19 946	25 929	19 946	33 243	47 328
73	National Aerospace University "Kharkiv Aviation Institute named after N.S. Kamanin"	Kharkiv region	21 007	23 341	27 243	23 341	38 902	27 243
74	National Pedagogical University named after M.P. Drahomanova	m. Kyiv	19 763	21 959	28 547	21 959	36 598	47 328
75	National Technical University "Dnipro Polytechnic"	Dnipropetrovsk region	12 589	13 988	18 184	13 988	23 313	32 253
76	National Technical University "Kharkiv Polytechnic Institute"	Kharkiv region	17 817	19 796	25 735	19 796	32 994	27 243
77	National Transport University	m. Kyiv	15 420	17 133	22 273	17 133	28 595	47 328
78	National University "Kyiv-Mohyla Academy"	m. Kyiv	16 919	18 799	24 438	18 799	31 331	47 328
79	Odesa Maritime Academy National University	Odesa region	23 188	25 764	27 738	25 764	42 940	27 738
80	Ostroh Academy National University	Rivne region	16 098	17 887	23 253	17 887	29 812	26 901
81	National University "Poltava Polytechnic named after Yuriy Kondratyuk"	Poltava region	14 761	16 401	21 322	16 401	27 335	29 538
82	Chernihiv Collegium National University named after T.G. Shevchenko	Chernihiv region	14 165	15 738	20 460	15 738	26 231	24 618
83	Zaporizhzhia Polytechnic National University	Zaporizhzhia region	10 746	11 940	15 522	11 940	19 800	31 440
84	Lviv Polytechnic National University	Lviv region	20 453	22 725	27 813	22 725	37 875	27 813
85	Odesa Law Academy National University	Odesa region	27 738	27 738	27 738	26 721	54 876	27 738
86	National University of Bioresources and Nature Management of Ukraine	m. Kyiv	17 395	19 328	25 127	19 328	32 214	47 328
87	National University of Water Management and Nature Management	Rivne region	12 414	13 793	17 931	13 793	22 988	26 901
88	National University of Shipbuilding named after adm. Makarov	Mykolayiv region	14 126	15 695	20 404	15 695	25 159	29 928
89	National University of Physical Education and Sports of Ukraine	m. Kyiv	22 366	24 851	32 306	24 851	41 415	47 328
90	National University of Food Technologies	m. Kyiv	16 077	17 863	23 222	17 863	29 772	47 328
91	National University named after Yaroslav the Wise	Kharkiv region	27 243	27 243	27 243	38 120	63 533	27 243

№ з/п	The name of the higher education institution (a separate structural subdivision of the higher education institution)	Region (Autonomous Republic of Crimea, including Kyiv, Sevastopol)	the minimum fee for 1 year of contract study for full-time higher education** that an institution of higher education can set for persons enrolled in 2020 to obtain a degree:			information for calculating the minimum fee for 1 year of study under a contract for a full-time education visa, which a higher education institution can set for persons enrolled in 2020		
			JUNIOR BACHELOR	BACHELOR (master's degree in medical, pharmaceutical, veterinary field)	MASTER	60% of the indicative cost price	100% of the indicative cost price	Average monthly wages of full-time employees in 2019 in the region (Autonomous Republic of Crimea, e.g. Kyiv, Sevastopol) by the location of the higher education institution for the previous calendar year according to the State Statistics
92	Nemyslav Agrotechnical College of the National University of Biore	Kyiv region	12 345	13 717	-	13 717	22 862	33 009
93	Nizhyn Agrotechnical College of the National University of Biore	Chernihiv region	9 540	10 600	-	10 600	17 667	24 618
94	Mykola Gogol Nizhyn State University	Chernihiv region	19 721	21 912	24 618	21 912	36 520	24 618
95	NTUU "Ihor Sikorsky Kyiv Polytechnic Institute"	m. Kyiv	23 301	25 890	33 657	25 890	43 150	47 328
96	Odesa State Academy of Construction and Architecture	Odesa region	15 258	16 954	22 040	16 954	28 256	27 738
97	Odesa State Academy of Technical Regulation and Quality	Odesa region	13 508	15 009	19 512	15 009	25 015	27 738
98	Odesa National Academy of Communication named after A.S. Popo	Odesa region	14 454	16 060	20 878	16 060	26 767	27 738
99	Odesa National Academy of Food Technologies	Odesa region	22 429	24 922	27 738	24 922	41 536	27 738
100	Odesa State Agrarian University	Odesa region	12 816	14 240	18 512	14 240	23 734	27 738
101	Odesa State Environmental University	Odesa region	24 074	26 748	27 738	26 748	44 581	27 738
102	Odesa National University of Economics	Odesa region	22 801	25 334	27 738	25 334	42 224	27 738
103	Odesa National Maritime University	Odesa region	12 845	14 272	18 554	14 272	23 787	27 738
104	Odesa National Polytechnic University	Odesa region	18 143	20 159	26 207	20 159	33 599	27 738
105	Odesa National University named after I.I. Mechnikova	Odesa region	17 991	19 990	25 986	19 990	33 316	27 738
106	Odesa Institute of Trade and Economics KNUTE	Odesa region	27 738	27 738	27 738	45 097	75 161	27 738
107	Pereyaslav-Khmelnytsky State Pedagogical University named after	Kyiv region	11 535	12 817	16 662	12 817	21 362	33 009
108	South Ukrainian National Pedagogical University named after K.D.	Odesa region	15 777	17 530	22 789	17 530	29 217	27 738
109	Podilsk State Agrarian and Technical University	Khmelnytskyi region	14 274	15 860	20 618	15 860	26 434	26 016
110	Podilsk special educational and rehabilitation socio-economic college	Khmelnytskyi region	11 180	12 422	-	12 422	20 703	26 016
111	Poltava State Agrarian Academy	Poltava region	10 462	11 624	15 112	11 624	19 374	29 538
112	Poltava National Pedagogical University named after V.G. Korolenko	Poltava region	15 413	17 125	22 263	17 125	28 542	29 538
113	Azov State Technical University	Donetsk region	15 379	17 088	22 215	17 088	28 480	35 148
114	Dnipro State Academy of Physical Education and Sports	Dnipropetrovsk region	32 216	32 253	32 253	35 795	59 659	32 253
115	Rivne State Humanities University	Rivne region	15 837	16 708	21 721	16 708	27 847	26 901
116	Rivne College of the National University of Bioreources and Nature	Rivne region	13 671	15 190	-	15 190	25 316	26 901
117	Sumy State Pedagogical University named after A.S. Makarenko	Sumy region	15 332	17 036	22 146	17 036	28 393	25 737
118	Sumy State University	Sumy region	11 156	12 395	16 114	12 395	20 659	25 737
119	Sumy National Agrarian University	Sumy region	10 662	11 846	15 400	11 846	19 744	25 737
120	East European National University named after Lesya Ukrainka	Volyn region	12 783	14 204	18 465	14 204	23 673	25 989
121	Eastern Ukrainian National University named after Volodymyr Dahl	Luhansk region	15 367	17 074	22 196	17 074	28 457	26 150
122	Tavria National University named after V.I. Vernadskyi	Zaporizhzhia region	12 553	13 948	18 133	13 948	23 247	31 440
123	Ternopil National Technical University named after Ivan Pulyu	m. Kyiv	10 877	12 086	15 712	12 086	20 143	47 328
124	Ternopil National Pedagogical University named after Volodymyr	Ternopil region	15 728	17 476	22 719	17 476	29 126	24 825
125	Dmytro Motorny Tavri State Agrotechnical University	Ternopil region	14 560	16 178	21 031	16 178	26 963	24 825
126	Ternopil National University of Economics	Ternopil region	10 843	12 047	15 662	12 047	20 079	24 825
127	Technical College of the National University of Water Management	Rivne region	6 069	6 743	-	6 743	11 238	26 901
128	Uzhhorod Trade and Economic Institute of KNUTE	Transcarpathian region	27 606	27 606	27 606	45 337	75 562	27 606
129	Ukrainian Academy of Printing	Lviv region	16 645	18 494	24 643	18 494	30 824	27 813
130	Ukrainian Engineering and Pedagogical Academy	Kharkiv region	19 421	21 579	27 243	21 579	35 965	27 243
131	Ukrainian State University of Railway Transport	Kharkiv region	12 876	14 307	18 599	14 307	23 645	27 243
132	Uman State Pedagogical University named after Pavlo Tychyna	Cherkasy region	11 815	13 128	17 066	13 128	21 880	26 514
133	Uman National University of Horticulture	Cherkasy region	10 358	11 508	14 961	11 508	19 181	26 514
134	University of Customs and Finance	Dnipropetrovsk region	21 092	23 435	30 466	23 435	39 059	32 253
135	Kharkiv State Academy of Physical Culture	Kharkiv region	21 398	23 775	27 243	23 775	39 625	27 243
136	Kharkiv State Zooveterinary Academy	Kharkiv region	12 996	14 440	18 772	14 440	24 967	27 243
137	Kharkiv State University of Food and Trade	Kharkiv region	18 506	20 562	26 731	20 562	34 271	27 243
138	Kharkiv National Automobile and Road University	Kharkiv region	13 440	14 933	19 413	14 933	24 889	27 243

№ з/п	The name of the higher education institution (a separate structural subdivision of the higher education institution)	Region (Autonomous Republic of Crimea, including Kyiv, Sevastopol)	the minimum fee for 1 year of contract study for full-time higher education** that an institution of higher education can set for persons enrolled in 2020 to obtain a degree:			information for calculating the minimum fee for 1 year of study under a contract for a full-time education visa, which a higher education institution can set for persons enrolled in 2020		
			JUNIOR BACHELOR	BACHELOR (master's degree in medical, pharmaceutical, veterinary field)	MASTER	60% of the indicative cost price	100% of the indicative cost price	Average monthly wages of full-time employees in 2019 in the region (Autonomous Republic of Crimea, e.g. Kyiv, Sevastopol) by the location of the higher education institution for the previous calendar year according to the State Statistics
139	Kharkiv National Agrarian University named after V.V. Dokuchaeva	Kharkiv region	22 040	24 489	27 243	24 489	40 916	27 243
140	Semyon Kuznets Kharkiv National University of Economics	Kharkiv region	17 704	19 671	25 672	19 671	32 785	27 243
141	Kharkiv National Pedagogical University named after H.S. Frying pans	Kharkiv region	17 608	19 565	25 434	19 565	32 608	27 243
142	Kharkiv National Technical University of Agriculture named after Petr	Kharkiv region	14 939	16 599	21 579	16 599	27 665	27 243
143	Kharkiv National University of Construction and Architecture	Kharkiv region	17 352	19 280	25 065	19 280	32 134	27 243
144	Kharkiv National University named after N.V. Karazin	Kharkiv region	16 454	18 283	23 767	18 283	30 471	27 243
145	Kharkiv National University of Urban Economy named after O.M. Bek	Kharkiv region	11 853	13 170	17 121	13 170	21 950	27 243
146	Kharkiv National University of Radio Electronics	Kharkiv region	13 745	15 272	19 854	15 272	25 453	27 243
147	Kharkiv Trade and Economic Institute KNTEU	Kharkiv region	27 243	27 243	27 243	33 427	55 712	27 243
148	Kherson State Maritime Academy	Kherson region	11 880	13 200	17 160	13 200	22 000	24 561
149	Kherson State Agrarian University	Kherson region	12 379	13 755	17 881	13 755	22 925	24 561
150	Kherson State University	Kherson region	16 678	18 531	24 090	18 531	30 885	24 561
151	Kherson National Technical University	Kherson region	16 474	18 305	23 796	18 305	30 508	24 561
152	Khmelnytsky National University	Kherson region	12 772	14 191	18 449	14 191	23 652	26 016
153	Central Ukrainian State Pedagogical University named after Volodym	Kirovohrad region	13 847	15 385	20 001	15 385	25 842	25 080
154	Central Ukrainian National Technical University	Kirovohrad region	13 277	14 753	19 178	14 753	24 588	25 080
155	Cherkasy State Technical University	Cherkasy region	13 805	15 339	19 941	15 339	25 568	26 514
156	Chernivtsi Trade and Economic Institute KNTEU	Cherkasy region	14 369	15 966	20 756	15 966	26 610	26 514
157	Chernivtsi National University named after Yuriy Fedkovich	Chernivtsi region	10 828	12 031	15 641	12 031	20 052	24 198
158	Cherkasy National University named after Bohdan Khmelnytskyi	Chernivtsi region	21 460	23 844	24 198	23 844	39 740	24 198
159	Chernihiv National Technological University	Chernihiv region	14 413	16 014	20 818	16 014	26 690	24 618
160	Petro Mohyla Black Sea National University	Mykolayiv region	15 236	16 929	22 008	16 929	28 215	29 928

*According to the decree of the Cabinet of Ministers of Ukraine dated February 19, 2020 No. 199-r "Some issues of the reorganization of educational institutions" (with changes), the State University of Economics and Technologies was established
** For the evening form of higher education, a factor of 0.85 is applied from the size of the indicative cost determined for the corresponding degree of higher education obtained by full-time or dual form, for correspondence and distance forms of education, the factor is applied - 0.35 from the size of the indicative cost the cost price determined for the corresponding degree of higher education, which is obtained on a full-time or dual basis.