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PHD THESIS

**MODELS AND METHODS OF COMPETENCY-BASED HUMAN
RESOURCE MANAGEMENT OF EDUCATIONAL PROJECTS**

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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SUMMARY

Zhou Huan. Models and methods of competency-based human resource management of educational projects. – *Qualifying scientific work as a manuscript.*

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Abstract content. The dissertation is devoted to constructing models and methods of competency-based human resource management of educational projects implemented at universities and taking into account the peculiarities of management in a turbulent environment (pandemic, martial law, etc.). The built models and methods are designed to solve the urgent scientific and practical task of ensuring the planned effective implementation of educational projects from planning to implementation.

In recent decades, the awareness of the importance of education development for sustainable economic growth has gained importance. To enhance the improvement of the quality of education, educational initiatives are being implemented, including those of an international nature, and international educational projects are being created and implemented. These projects aim to share experiences and implement interactive teaching methods, improve the efficiency of knowledge acquisition and program results, etc. To ensure the success of such initiatives and the effective implementation of educational projects, it is necessary to engage highly qualified performers whose competencies meet the needs of a particular educational project. Since projects usually have a complex structure, practical work requires the participation of specialists from different fields of knowledge in the tasks set. An educational project is created and implemented for educational purposes. Accordingly, we can consider the project as an educational program or a set of programs that include educational components, each allowing you to learn the relevant program results and for each of which one or more performers or research and teaching staff may be responsible. It is

essential to understand that performance competencies may change during project implementation and are not static.

For the quality implementation of an educational project, the involvement of performers should be continuous, especially in a turbulent environment. To include potential teachers in the project working group, it is necessary to form a system of indicators based on the testing of students of the courses provided by these teachers. It should be noted that the evaluation of the project is shaped by the results of the work of its implementers, who have certain dynamically changing competencies. Therefore, the evaluation of an educational project changes over time.

For effective human resource management, a system should be developed that should be integrated into the training system of target groups of students. This system should also integrate with services for finding students interested in obtaining knowledge in a particular specialty. With such integration, human resource assessment and management will be complete.

The idea of creating methods and models for managing human resources of educational projects, in particular in a turbulent environment (COVID-19 pandemic, martial law, etc.), as well as taking into account the assessment of academic staff based on the results of testing target groups of students on the achievement of program results in the educational components for which these employees are responsible, is a new vision that expands theoretical knowledge in this area. At the same time, the applied solution for integrating the developed methods and models into the learning platform with integration with the student service opens up new opportunities for filling the database with the evaluations of academic staff, increases the efficiency of both student learning and allows to effectively solve the problem of selecting the executors of educational projects or employees who teach educational components within certain educational programs. The described solutions are integrated and supported during the life cycle of an educational project or the period of creation and operation of an educational program with all its features.

This paper solves an important task, namely, the development of methods and models for managing human resources of educational projects to improve the efficiency of their implementation, taking into account their life cycle, the turbulence of the external environment and the peculiarities of competency-based assessment of their performers, which are inherent in educational projects (scientific component). It also solves the critical task of automating human resource management within educational projects. It is based on developing a management system that integrates into the learning platform and is linked to a service for students (practical component).

The object of research is the processes of human resource management of educational projects and decision-making based on a competency-based assessment of their performers.

The subject of the study is methods and models of human resource management of educational projects in a turbulent environment, taking into account the peculiarities of competency-based assessment of the performance of their performers.

Research methods. The research is based on representing and processing knowledge, evaluation methods, modeling and theory of optimization, decision-making, and object-oriented programming.

The study aims to develop methods and models for managing human resources of educational projects based on competency-based performance assessment of their executors to improve the efficiency of project implementation, especially in a turbulent environment.

The scientific novelty of the results:

- for the first time, a multiple model of the life cycle of an educational project has been developed, which takes into account the stages of planning, development, implementation, operation and completion of the project and provides opportunities for project improvement if changes are needed and provides the necessary level of formalization for the further application of methods and models of educational project management;

- a competency-based method of managing the composition of the working team of an educational project has been developed for the first time, taking into account the peculiarities of adapting the resource provision of an educational project in the face of environmental turbulence;

- the model of managing the composition of the working group of the educational project with the formation of a reserve of performers who are evaluated based on the results of students' completion of educational components for which these performers are responsible, which in turn allows an increase the efficiency of managing an educational project in a turbulent environment;

- the principles of integration of the human resources management system with the learning platform and student service were improved, which significantly enhances the ability to evaluate the executors of educational projects based on the learning outcomes of students of educational components;

- the conceptual representation of the links between educational components, performers, program results and participants of the educational project was further developed, which is determined by its structure and takes into account the results of the evaluation of performers as a result of the student's knowledge acquisition, and also takes into account the conditions of environmental turbulence, which leads to the formation and evaluation of reserves of educational project performers, and in general expands the theoretical and practical possibilities of ensuring the effectiveness of educational projects.

The first section analyzes and establishes that there are gaps in the development of human resource management information technologies, in particular e-governance, and that research is fragmented and practically does not take into account the special conditions of the organization's functioning and external undesirable influences: a pandemic, an economic crisis, a military conflict. At the same time, the private sector's interest in developing this area is growing every year. Thus, the main areas for research relate to the use of information technology for human resource management tasks in general, and their adaptation to special or critical operating conditions is especially relevant. The principles and

methods of human resource management are presented, the shortcomings of existing methods are indicated.

The current state of development of human resource management systems is analyzed, and a review of well-known systems is carried out. It is established that these well-known tools cannot be effectively used for the task of managing human resources of educational projects due to their specificity: it is difficult to assess the productivity of project executors (qualitative assessments are available, productivity is influenced by many factors), it is difficult to achieve the goals of an educational project in conditions of change and uncertainty, when the external environment is turbulent (military conflict, pandemic), in the context of educational transformation, competency-based methods must have an adaptive property and adapt to the ab The obtained results are important for ensuring the impartial formation of the project team and human resource management, in particular on the basis of competency-based methods. The results are important for higher education institutions and project managers, including educational and scientific ones.

In the second section, the constructed multiple model of the life cycle of an educational project defines the various stages and stages of development of an educational project from its beginning to its completion. The scheme of transition of projects between the stages of the life cycle and improvement of the educational project is also described. The case when an educational project cannot continue and is completed, the case when a new educational project is created, and the case when an educational project is transformed. That is, the section formally considers all possible changes that may occur in the life cycle.

The general structure of the educational project is formally described, which includes project components or tasks, as well as programmatic outputs or project results. The conceptual scheme of the relationship between components, performers, results, and participants of the educational project is also described. The feature that distinguishes this organizational structure from the known ones is the emphasis on the educational project, the purpose of which is to train students or

students with the possibility of assessing the quality of work of teachers who are the executors of the educational project as a training program. The relationship between educational components and educational project implementers or teachers is formally described. The connection between the components and program results is also described.

A model for the formation of a working group of educational project executors has been built, taking into account the peculiarities of the implementation and structure of educational projects carried out for educational purposes at universities, the fact that the executor may belong to several projects at the same time, etc. The developed concept of managing the composition of the educational project working group takes into account the conditions of environmental turbulence due to the pandemic, martial law, etc. This concept envisages the formation of a so-called human resource reserve, which is formed based on the results of teaching by academic staff of other disciplines. This reserve opens up opportunities to engage educational project implementers or teachers at critical times.

The third section describes a competency-based method for managing the composition of the working team of an educational project and a method for adapting the resource provision of an educational project in the face of environmental turbulence. Also, to enhance the adaptability of resource provision, the method of creating clusters of educational projects based on a competency-based approach is proposed within this method, which allows solving the problem of providing educational projects with performers of the required qualifications and increasing the efficiency of educational project implementation.

The fourth section describes the principles of integrating the human resource management system with the learning platform and student service, which significantly expands the possibilities for evaluating educational project implementers based on the learning outcomes of students of educational components. A remote procedure call scheme is described that applies the principles of encapsulation to the integration of an application for training and

human resource management and a service for students. The effectiveness of the application of human resource management methods for educational projects developed in this study was evaluated.

The practical significance of the results obtained is that the developed methods and models of human resource management of educational projects are the basis for ensuring the effectiveness of their implementation, in particular, improving the quality of teaching and learning of students, students of educational components, and in general, improving the quality of the educational process, which meets the main goal of the projects. In the short term, the use of theoretical and practical results will make it possible to improve the quality of the educational process by attracting the best specialists to teach the relevant educational components based on a competency-based approach, regardless of the impact of environmental turbulence on this process. In the long term, the use of the developed methods and models will have a positive impact on the development of the quality of education in general. The main provisions and results of the research were implemented and applied in the activities of Yancheng Politechnic College.

The results obtained, both in theoretical and practical terms, serve as a basis for further scientific and applied research aimed at improving and ensuring the sustainable development of universities. This meets the requirements of international systems for monitoring their educational activities.

Keywords: educational project, competency-based method, project management, mathematical model, educational component, human resource management, evaluation of the productivity of project executors, program result.

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. **Zhou, Huan.** (2019). Development of the System Model for HR-Management in Joint Educational Projects. *Management of Development of Complex Systems*, 37, 127 – 131, dx.doi.org\10.6084/m9.figshare.9783128 [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-37/22.pdf>

2. **Zhou, Huan.** (2019). Trends in the use of IT in human resource management, for example, of higher education institutions in China. *Management of Development of Complex Systems*, 38, 125 – 131, dx.doi.org\10.6084/m9.figshare.9788576. [category «B»] http://urss.knuba.edu.ua/files/zbirnyk-38/21_0.pdf

3. **Zhou, Huan.** (2020). Harmonization of Chinese International Student Service System. *Management of Development of Complex Systems*, 41, 147 – 155, dx.doi.org\10.32347/2412-9933.2020.41.147-155. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-41/22.pdf>

4. **Zhou, Huan.** (2023). Information technology for the management of human resources of education projects. *Management of Development of Complex Systems*, 52, 128–132. <https://doi.org/10.32347/2412-9933.2023.55.128-132> [category «B»] <http://mdcs.knuba.edu.ua/article/view/291116>

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1. **Zhou, Huan.** Trends in the use of it in human resource management on the example of chinese higher education institutions. *Science Journal Innovation Technologies Transfer*. 24-30. 10.36381/iamsti.4.2020.24-30. <http://www.iamsti.org.ua/sjitt-2020-4-09/>

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АНОТАЦІЯ

Чжоу Хуань. Моделі та методи компетентнісно-орієнтованого управління людськими ресурсами освітніх проєктів. – 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 побудові моделей та методів компетентнісно-орієнтованого управління людськими ресурсами освітніх проєктів, які виконуються в університетах і враховують особливості управління в умовах турбулентності зовнішнього середовища (пандемія, військовий стан тощо). Побудовані моделі та методи призначені для вирішення

актуального науково-практичного завдання забезпечення запланованої ефективної реалізації освітніх проєктів від планування до впровадження.

Протягом останніх десятиліть набуло значення усвідомлення важливості розвитку освіти для забезпечення сталого економічного зростання держави. Для активізації удосконалення якості освіти впроваджуються освітні ініціативи, включаючи ті, що мають міжнародний характер, створюються та реалізуються міжнародні освітні проєкти. Ці проєкти спрямовані на обмін досвідом та впровадження інтерактивних методів навчання, підвищення ефективності засвоєння знань і програмних результатів тощо. Для забезпечення успішності таких ініціатив та ефективної реалізації освітніх проєктів вимагається залучення висококваліфікованих виконавців, чії компетентності відповідають потребам конкретного освітнього проєкту. Оскільки проєкти, як правило, мають складну структуру, ефективна робота вимагає участі фахівців з різних галузей знань, відповідно до поставлених завдань. Освітній проєкт створюється та впроваджується для навчальних цілей. Відповідно можемо розглядати проєкт як освітня програма чи комплекс програм, які включають освітні компоненти, кожна з яких дозволяє засвоїти відповідні програмні результати та за кожен з яких може відповідати один або декілька виконавців або науково-педагогічних працівників. Важливо розуміти, що компетентності виконавців можуть змінюватися протягом реалізації проєктів та не є статичними.

Для якісного виконання освітнього проєкту залучення виконавців має відбуватися неперервно, особливо в умовах турбулентності зовнішнього середовища. Для включення потенційних викладачів до робочої групи проєкту потрібно сформулювати систему показників, які формуються на основі тестування слухачів курсів, які забезпечують ці викладачі. Слід зазначити, що оцінку проєкту формують результати роботи його виконавців, які мають певні компетентності, що динамічно змінюються. Відтак, змінюється і оцінка освітнього проєкту з часом.

Для ефективного управління людськими ресурсами має бути розроблена система, яка повинна бути інтегрована в систему навчання цільових груп слухачів. Також ця система має інтегруватися з сервісами для пошуку студентів, які зацікавлені в отриманні знань з певної спеціальності. Без такої інтеграції оцінка та управління людськими ресурсами буде неповноцінним.

Ідея створення методів та моделей управління людськими ресурсами освітніх проєктів, зокрема в умовах турбулентності зовнішнього середовища (пандемія COVID-19, воєнний стан тощо), а також враховуючи оцінювання науково-педагогічних працівників за результатами тестування цільових груп слухачів щодо досягнення ними програмних результатів в освітніх компонентах, за які відповідають ці працівники є новим баченням, що розширяє теоретичні знання в цьому напрямку. При цьому прикладне рішення щодо інтеграції розроблених методів та моделей до інформаційної платформи навчання з інтеграцією та сервісом для студентів, відкриває нові можливості наповнення бази даних з оцінками науково-педагогічних працівників. Також такий підхід підвищує ефективність як навчання студентів, так і дозволяє ефективно розв'язати задачу вибору виконавців освітніх проєктів або працівників, які викладають освітні компоненти в межах певних освітніх програм. Описані рішення у роботі інтегровані і підтримуються в процесі життєвого циклу освітнього проєкту або періоду створення та функціонування освітньої програми з усіма її особливостями.

В даній роботі вирішується важливе завдання, а саме: розроблення методів та моделей управління людськими ресурсами освітніх проєктів для підвищення ефективності їх реалізації, враховуючи їх життєвий цикл, турбулентність зовнішнього середовища та особливості компетентнісно-орієнтованого оцінювання їх виконавців, які притаманні освітнім проєктам (наукова складова). Також вирішується важлива задача автоматизації управління людськими ресурсами в межах освітніх проєктів, що заснована на розробленні системи управління, яка інтегрується до навчальної

інформаційної платформи та пов'язана з сервісом для студентів (практична складова).

Об'єктом дослідження є процеси управління людськими ресурсами освітніх проєктів та прийняття рішень на основі компетентнісно-орієнтованого оцінювання виконавців таких проєктів.

Предметом дослідження є методи та моделі управління людськими ресурсами освітніх проєктів в умовах турбулентності зовнішнього середовища з врахуванням особливостей компетентнісно-орієнтованого оцінювання продуктивності виконавців таких проєктів.

Методи дослідження. Проведені дослідження базуються на методах представлення і обробки знань, методах оцінювання, моделювання та теорії оптимізації, прийняття рішень, об'єктно-орієнтованого програмування.

Метою дослідження є підвищення ефективності виконання освітніх проєктів зарахунок розроблення та впровадження методів та моделей управління людськими ресурсами таких проєктів на основі компетентнісно-орієнтованого оцінювання продуктивності їх виконавців, особливо в умовах впливів турбулентності зовнішнього середовища.

Наукова новизна отриманих результатів:

- вперше розроблено множинну модель життєвого циклу освітнього проєкту, що враховує етапи планування, розробки, впровадження, експлуатації та завершення проєкту та передбачає можливості для вдосконалення проєкту за необхідності впровадження змін та забезпечує необхідний рівень формалізації, необхідний для подальшого застосування методів та моделей управління освітніми проєктами;
- вперше розроблений компетентнісно-орієнтований метод управління складом робочої команди освітнього проєкту, що враховує особливості адаптації ресурсного забезпечення освітнього проєкту за умови впливів турбулентності зовнішнього середовища;
- удосконалено модель управління складом робочої групи освітнього проєкту з формуванням резерву виконавців, які оцінюються за

результатами проходження слухачами освітніх компонент, за які відповідають ці виконавці, що в свою чергу дозволяє підвищити ефективність управління освітнім проєктом в умовах турбулентності зовнішнього середовища;

- удосконалено принципи інтеграції системи управління людськими ресурсами з платформою для навчання та сервісом для студентів, що дозволяє значно розширити можливості для оцінювання виконавців освітніх проєктів на основі результатів навчання слухачів освітніх компонент;

- отримало подальший розвиток концептуального представлення зв'язків між освітніми компонентами, виконавцями, програмними результатами та учасниками освітнього проєкту, що визначається його структурою та враховує результати оцінювання виконавців, як результат засвоєння слухачами знань, а також враховує умови турбулентності зовнішнього середовища, що призводить до формування та оцінювання резервів виконавців освітнього проєкту, а в цілому розширює теоретичні та практичні можливості забезпечення ефективності реалізації освітніх проєктів.

У першому розділі проведено аналіз та встановлено, що в напрямку розвитку інформаційних технологій управління людськими ресурсами, зокрема електронного управління є розриви, дослідження фрагментарні та практично не враховують особливі умови функціонування організації організації та не враховуються зовнішні небажані впливи: пандемія, економічна криза, воєнний конфлікт. При цьому інтерес приватного сектору у розвитку цього напрямку з кожним роком зростає. Таким чином, основні напрямки для досліджень стосуються застосування інформаційних технологій для вирішення задач управління людськими ресурсами на усіх етапах життєвого циклу освітніх проєктів та їх адаптація до особливих або критичних умов функціонування таких проєктів. Наведено принципи та

методи управління людськими ресурсами, вказано які є недоліки наявних методів.

Проаналізовано сучасний стан розвитку систем управління людськими ресурсами, проведено огляд відомих систем. Встановлено, що вказані відомі інструменти не можуть бути ефективно використані для задачі управління людськими ресурсами освітніх проєктів через їх специфіку: складно оцінити продуктивність виконавців проєктів (наявні якісні оцінки, на продуктивність впливає багато факторів), складно досягнути цілі освітнього проєкту в умовах змін та невизначеності, коли зовнішнє середовище турбулентне (військовий конфлікт, пандемія), в умовах трансформації освіти компетентнісно-орієнтовані методи повинні мати адаптивну властивість і пристосовуватись до тієї або іншої освітньої системи. Отримані результати важливі для забезпечення неупередженого формування команди проєкту та управління людськими ресурсами, зокрема на основі компетентнісно-орієнтованих методів. Отримані результати мають значення для закладів вищої освіти та керівників проєктів, в тому числі освітніх та наукових.

В другому розділі побудована множинна модель життєвого циклу освітнього проєкту визначає різні фази з врахуванням етапів розвитку освітнього проєкту від його початку до завершення. Також надано опис схеми переходу проєктів між етапами життєвого циклу та вдосконалення освітнього проєкту. Розглянуто випадок, коли освітній проєкт не може далі продовжуватися і завершується, випадок, коли створюється новий освітній проєкт, та випадок, коли освітній проєкт трансформується. Тобто формально в розділі розглянуті всі можливі зміни, які можуть бути у життєвому циклі освітнього проєкту.

Описано формально загальну структуру освітнього проєкту, яка включає компоненти або завдання проєкту, а також програмні результати або результати проєкту. Також надано опис концептуальної схеми зв'язків між компонентами, виконавцями, результатами та учасниками освітнього проєкту. Особливістю, що вирізняє запропоновану організаційну структуру

від відомих, є акцент на освітньому проєкті, ціллю якого є навчання слухачів або студентів з можливістю оцінювання якості роботи викладачів, які є виконавцями освітнього проєкту, як програми навчання. Надано формальний опис зв'язків освітніх компонент та виконавців освітнього проєкту або викладачів. Також надано опис зв'язків компонент та програмних результатів.

Побудовано модель формування робочої групи виконавців освітнього проєкту, що враховує особливості виконання та структури освітніх проєктів, які виконуються для навчальних цілей в університетах, де один виконавець може належати одночасно до кількох проєктів тощо. Побудована концепція управління складом робочої групи освітнього проєкту, що враховує умови турбулентності зовнішнього середовища у зв'язку з пандемією, воєнним станом тощо. Така концепція передбачає формування так званого резерву людських ресурсів, що формується за результатами викладання науково-педагогічними працівниками інших дисциплін. Цей резерв відкриває можливості для залучення виконавців освітнього проєкту або викладачів у критичні моменти часу.

В третьому розділі надано опис компетентісно-орієнтованого методу управління складом робочої команди освітнього проєкту та методу адаптації ресурсного забезпечення освітнього проєкту за умови впливів турбулентності зовнішнього середовища. Також, межах даного методу, для підсилення адаптивності ресурсного забезпечення запропоновано метод створення кластерів освітніх проєктів на основі компетентісного підходу, що дозволяє вирішити проблему забезпечення освітніх проєктів виконавцями необхідної кваліфікації та підвищити ефективність реалізації освітнього проєкту.

У четвертому розділі надано опис принципів інтеграції інформаційної системи управління людськими ресурсами з платформою для навчання та сервісом для студентів, що дозволяє значно розширити можливості для оцінювання виконавців освітніх проєктів на основі результатів навчання слухачів освітніх компонент. Описано схему віддаленого виклику процедур,

що застосовує принципи інкапсуляції до інтеграції застосування для навчання та управління людськими ресурсами та сервісу для студентів. Проведено оцінку ефективності застосування методів управління людськими ресурсами освітніх проєктів, які були розроблені в даному дослідженні.

Практичне значення одержаних результатів полягає у тому, що розроблені методи та моделі управління людськими ресурсами освітніх проєктів забезпечують ефективність їх виконання, зокрема підвищення якості викладання та навчання студентів, слухачів освітніх компонент, і загалом, підвищення якості забезпечення освітнього процесу, що відповідає основним цілям проєктів. В короткій перспективі використання теоретичних та практичних результатів надасть можливість підвищити якість забезпечення освітнього процесу за рахунок залучення кращих спеціалістів до викладання відповідних освітніх компонент на основі компетентнісно-орієнтованого підходу, незалежно від впливу на цей процес турбулентностей зовнішнього середовища. В довготривалій перспективі використання розроблених методів та моделей дасть позитивний вплив на розвиток якості освіти в цілому. Основні положення та результати дослідження впроваджено та застосовано в діяльності Яньченського політехнічного коледжу.

Отримані результати, як у теоретичному, так і практичному плані, є основою для подальших науково-прикладних досліджень, спрямованих на поліпшення якості навчання та забезпечення сталого розвитку університетів. Це відповідає вимогам міжнародних систем моніторингу освітньої діяльності.

Ключові слова: освітній проєкт, компетентнісно-орієнтований метод, управління проєктами, математична модель, освітня компонента, управління людськими ресурсами, оцінка продуктивності виконавців проєктів, програмний результат.

СПИСОК ПУБЛІКАЦІЙ ЗДОБУВАЧА ЗА ТЕМОЮ ДИСЕРТАЦІЇ

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INTRODUCTION

In recent decades, the importance of education development for sustainable economic growth has become increasingly recognized. To enhance the improvement of the quality of education, educational initiatives are being implemented, including those of an international nature, and international educational projects are being created and implemented. These projects aim to share experience and implement interactive teaching methods, improve the efficiency of knowledge acquisition and program results, etc. To ensure the success of such initiatives and the effective implementation of educational projects, it is necessary to engage highly qualified performers whose competencies meet the needs of a particular educational project. Since projects usually have a complex structure, practical work requires the participation of specialists from different fields of knowledge, by the tasks set. An educational project is created and implemented for educational purposes. Accordingly, we can consider the project as an educational program or a set of programs that include educational components, each allowing you to learn the relevant program results and for each of which one or more performers or research and teaching staff may be responsible. It is essential to understand that performance competencies may change during project implementation and are not static.

For the quality implementation of an educational project, the involvement of performers should be continuous, especially in a turbulent environment. To include potential teachers in the project working group, it is necessary to form a system of indicators based on testing of students of the courses provided by these teachers. It should be noted that the evaluation of the project is shaped by the results of the work of its implementers, who have specific dynamically changing competencies. Therefore, the evaluation of an educational project changes over time.

For effective human resource management, a system should be developed that should be integrated into the training system of target groups of students. This system should also integrate with services for finding students interested in

obtaining knowledge in a particular specialty. With such integration, human resource assessment and management will be complete.

The idea of creating methods and models for managing human resources of educational projects, in particular in a turbulent environment (COVID-19 pandemic, martial law, etc.), as well as taking into account the assessment of academic staff based on the results of testing target groups of students on the achievement of program results in the educational components for which these employees are responsible, is a new vision that expands theoretical knowledge in this area. At the same time, the applied solution for integrating the developed methods and models into the learning platform with integration with the student service opens up new opportunities for filling the database with the evaluations of academic staff, increases the efficiency of both student learning and allows to effectively solve the problem of selecting the executors of educational projects or employees who teach educational components within specific educational programs. The described solutions are integrated and supported during the life cycle of an educational project or the period of creation and operation of an educational program with all its features.

This paper solves an important task, namely, the development of methods and models for managing human resources of educational projects to improve the efficiency of their implementation, taking into account their life cycle, the turbulence of the external environment and the peculiarities of competency-based assessment of their performers, which are inherent in educational projects (scientific component). It also solves the critical task of automating human resource management within educational projects, based on developing a management system that integrates into the learning platform and is linked to a service for students (practical component).

The dissertation work was carried out at the Faculty of Information Technologies of Taras Shevchenko National University of Kyiv following the national strategy for the development of education in Ukraine for 2011-2027 and following 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 human resource management of educational projects and decision-making based on a competency-based assessment of their performers.

The subject of the study is methods and models of human resource management of educational projects in a turbulent environment, taking into account the peculiarities of competency-based assessment of the performance of their performers.

Research methods. The research is based on methods of representing and processing knowledge, evaluation methods, modeling and theory of optimization, decision-making, and object-oriented programming.

The study aims to develop methods and models for managing human resources of educational projects based on competency-based assessment of their executors' performance to improve project implementation efficiency, especially in a turbulent environment.

To achieve the goal, the following tasks must be solved:

1. Analyze information technologies for human resource management, present the principles and methods of human resource management, and identify the shortcomings of existing methods. In the context of the results obtained, improve existing mathematical tools and develop new ones to ensure the effective implementation of educational projects in the field of human resource management. To analyze the current state of development of human resource management systems, to review known systems.

2. To build a multiple model of the life cycle of an educational project that defines the various stages and stages of development of an educational project from its inception to completion. Describe the scheme of transition of projects between stages of the life cycle and improvement of the educational project.

3. Describe formally the overall structure of the educational project, which includes project components or tasks, as well as programmatic outputs or

project results. Also, describe the conceptual scheme of connections between components, performers, results, and participants of the educational project.

4. To build a model for the formation of a working group of educational project implementers, taking into account the peculiarities of the implementation and structure of educational projects carried out for educational purposes at universities, the fact that the performer may belong to several projects at the same time, etc. Describe the concept of managing the composition of the working group of an educational project, taking into account the conditions of environmental turbulence due to a pandemic, martial law, etc.

5. Describe the competency-based method of managing the composition of an educational project's working team and adapting the resource support of an educational project in the face of environmental turbulence.

6. Describe the principles of integrating the human resource management system with the learning platform, student services, and the scheme of remote procedure calls. Evaluate the effectiveness of applying human resource management methods for educational projects that will be developed in this study.

The scientific novelty of the results:

- for the first time, a multiple model of the life cycle of an educational project has been developed, which takes into account the stages of planning, development, implementation, operation and completion of the project and provides opportunities for project improvement if changes are needed and provides the necessary level of formalization for the further application of methods and models of educational project management;

- a competency-based method of managing the composition of the working team of an educational project has been developed for the first time, taking into account the peculiarities of adapting the resource provision of an educational project in the face of environmental turbulence;

- the model of managing the composition of the working group of the educational project with the formation of a reserve of performers who are evaluated based on the results of students' completion of educational components

for which these performers are responsible, which in turn allows an increase the efficiency of managing an educational project in a turbulent environment;

- the principles of integration of the human resources management system with the learning platform and student service were improved, which significantly enhances the ability to evaluate the executors of educational projects based on the learning outcomes of students of educational components;

- the conceptual representation of the links between educational components, performers, program results and participants of the educational project was further developed, which is determined by its structure and takes into account the results of the evaluation of performers as a result of the student's knowledge acquisition, and also takes into account the conditions of environmental turbulence, which leads to the formation and evaluation of reserves of educational project performers, and in general expands the theoretical and practical possibilities of ensuring the effectiveness of educational projects.

To solve the problems of the dissertation research, the first chapter analyzes and establishes that there are gaps in the development of human resource management information technologies, in particular e-governance; research is fragmented and practically does not take into account the special conditions of the organization's functioning and external undesirable influences: pandemic, economic crisis, military conflict. At the same time, the private sector's interest in developing this area is growing every year. Thus, the main areas for research related to the use of information technology for human resource management tasks in general, and their adaptation to unique or critical operating conditions is especially relevant. The principles and methods of human resource management are presented, and the shortcomings of existing methods are indicated.

The current state of human resource management systems development is analyzed, and a review of well-known systems is carried out. It is established that these well-known tools cannot be effectively used for the task of managing human resources of educational projects due to their specificity:

It is difficult to assess the productivity of project executors (qualitative assessments are available, but many factors influence productivity).

It is difficult to achieve the goals of an educational project in conditions of change and uncertainty.

When the external environment is turbulent (military conflict, pandemic), competency-based methods must have an adaptive property and adapt in the context of educational transformation. The results are essential for ensuring the impartial formation of the project team and human resource management, mainly based on competency-based methods.

The results, including educational and scientific, are essential for higher education institutions and project managers.

In the second section, the constructed multiple model of the life cycle of an educational project defines the various stages of development of an educational project from its inception to completion. The scheme of transition of projects between the stages of the life cycle and improvement of the educational project is also described. The case is when an educational project cannot continue and is completed, the case is when a new educational project is created, and the case is when an educational project is transformed. That is, the section formally considers all possible changes in the life cycle. The general structure of the educational project is formally described, which includes project components or tasks, as well as programmatic outputs or project results. The conceptual scheme of the relationship between components, performers, results, and participants of the educational project is also described. The feature that distinguishes this organizational structure from the known ones is the emphasis on the educational project, which aims to train students or students with the possibility of assessing the quality of work of teachers who are the executors of the educational project as a training program. The relationship between educational components and project implementers or teachers is formally described. The connection between the components and program results is also described.

A model for forming a working group of educational project executors has been built, taking into account the peculiarities of the implementation and structure of educational projects carried out for educational purposes at universities, the fact that the executor may belong to several projects simultaneously, etc. The developed concept of managing the composition of the educational project working group considers the conditions of environmental turbulence due to the pandemic, martial law, etc. This concept envisages the formation of a so-called human resource reserve, which is formed based on the results of teaching by academic staff of other disciplines. This reserve opens up opportunities to engage educational project implementers or teachers at critical times.

The third section describes a competency-based method for managing the composition of the educational project team and a method for adapting the resource support of an educational project in the face of environmental turbulence. Also, to enhance the adaptability of resource provision, the method of creating clusters of educational projects based on a competency-based approach is proposed, which allows solving the problem of providing educational projects with performers of the required qualifications and increasing the efficiency of educational project implementation.

The fourth section describes the principles of integrating the human resource management system with the learning platform and student service, which can significantly expand the possibilities for evaluating educational project implementers based on the learning outcomes of students of educational components. A remote procedure call scheme is described that applies the principles of encapsulation to integrate an application for training and human resource management and a service for students. The effectiveness of applying human resource management methods for educational projects developed in this study was evaluated.

The practical significance of the results obtained in this dissertation is as follows:

1. The developed methods and models of human resource management of educational projects are the basis for ensuring the effectiveness of their implementation, in particular, improving the quality of teaching and learning of students, students of educational components, and in general, improving the quality of the educational process, which corresponds to the main goal of the projects.

2. In the short term, the use of theoretical and practical results will make it possible to improve the quality of the educational process by attracting the best specialists to teach the relevant educational components based on a competency-based approach, regardless of the impact of environmental turbulence on this process.

3. In the long run, the use of the developed methods and models will positively impact the development of the quality of education in general.

4. The main provisions and results of the study were implemented and applied in the activities of Yancheng Politechnic College.

The results obtained, both in theoretical and practical terms, serve as a basis for further scientific and applied research to improve and ensure universities' sustainable development. Some critical studies in this area [1-111] have been analyzed and presented in this study. Also, the author published the main results of the work in the following publications [112-122].

Personal contribution of the acquirer. The applicant personally received the main provisions and results of the dissertation work. Paper [112] describes the peculiarities of developing systems and models for human resource management in educational projects. Paper [113] describes trends in the use of IT in human resource management, for example, of higher education institutions in China. Paper [114] describes the peculiarities of harmonizing and integrating the human resource management system with student services, particularly in the example of universities in the People's Republic of China. Paper [115] describes information technology for managing human resources of education projects and the peculiarities of building systems for human resource management based on a

competency-based method. Paper [116] describes methods of human resource management and their application. The materials from international conferences were also published, in which the provisions of the dissertation work are revealed in more detail [117-122]. Papers [117, 118] were published in journals indexed in the Scopus scientometric database, and paper [117] was published in a periodical indexed by CEUR.

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), "Technology Development Management", Kyiv (2020), Information Technology and Implementation, Kyiv (IT&I-2021), IEEE conference "Smart Information Systems and Technologies" (SIST-2021), Astana, Republic of Kazakhstan.

Publications. Based on the dissertation materials, 10 scientific works have been published, including 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, 5 materials of international conferences, two of them in publications that are indexed by the Scopus database. The main results of the work were obtained personally by the author. Of the scientific works published in co-authorship, the dissertation research describes those provisions resulting from the author's 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 144 pages, including 26 figures, 14 tables, a bibliography of 123 titles and 2 appendices.

CHAPTER 1. THEORETICAL FOUNDATIONS AND TASKS OF HUMAN RESOURCE MANAGEMENT OF EDUCATIONAL PROJECTS

1.1. Features of human resource management in organizations

The development of methods and models of human resource management in organizations has been and remains relevant, especially in the context of globalization, market revitalization and the creation of new organizations. It is also relevant under conditions of uncertainty, in the face of extreme events (COVID-19 pandemic, military conflicts, etc.). An important task in this context is to align human resource management methods with business strategies [1]. As the market is constantly transforming, it is important that human resource management methods correspond to it [2].

The development of information technologies and human resource management methods have a wide range of influences on each other. Human resource management professionals must be able to implement technologies that allow reengineering the HR function, be prepared to support organizational and work changes arising from technology development, and be able to maintain an appropriate management climate, in particular for innovative and knowledge-intensive organizations [3]. It should be noted that the development of technological achievements is generally due to the high requirements for the selection of human resources in such organizations [4].

The study [5] describes that through the use of information technologies, human resource management systems can solve problems more strategically, flexibly, cost-effectively and more customer-oriented. Many experts predict that information technology is the driver of successful work in the field of human resources management [6]. Virtualization of human resource management is caused by the factor of increasing complexity of information technology and increasing external structural parameters [7]. Information technologies enable organizations to carry out modern operations in human resource management. A

wide range of offers on the market of human resource management technologies allows using the most modern systems with minimal investment [8]. It should also be noted that the development of this area is especially important in conditions of uncertainty and emergencies, when the use of human resource management methods with predictable consequences is difficult.

The development of information technology makes it possible to plan and perform a large number of tasks, such as attracting, retaining and motivating employees, meeting the requirements for strategic HR functions, as well as managing the "human element" of technological change in the future [9-11].

High-quality use of human resources management methods can increase the efficiency of technological innovations to achieve high productivity of the organization [12, 13]. Work [14] indicates that the use of HRM methods allows automating routine tasks such as payroll processing, administration and transactional activities, so HR professionals can freely focus on more strategic issues such as increasing organizational productivity. Today, with increasing globalization, organizations and their environments are becoming increasingly complex. Managers in these organizations face increasing difficulties in managing employees who may be located in different countries, have different cultures and political views [15].

The significant advantages of communication and information technologies allow the development and use of human resource information systems (HRIS) [16, 17]. HRIS includes a systematic procedure for collecting, storing, preserving, retrieving and verifying data required by an organization for human resource management and personnel activities [18]. HRIS can also provide management with tools for making HR decisions [19]. Paper [20] offers numerous examples of how HR technology has improved the quality of service for employees in the workplace.

The research work of the HRIS consulting firm (Cincinnati, USA) of Insight Consulting partners [21] notes that enterprise applications tend to push organizations towards a more centralized and integrated human resources and IT

infrastructure. Thus, HRIS can support long-term planning and management of human resources, as well as calculate supply and demand forecasts, staffing, prepare program and internship costs, etc. It can also support compensation programs, calculate salary forecasts, budget planning, etc. [22]. Successful HRIS implementation requires a thorough needs analysis and depends on the ability of managers to manage change [23-27].

It should be noted that the use of information technology for HR management in organizations is underdeveloped [28, 29]. In particular, there are three new areas of development in this area that require more empirical research [30]:

- innovations in information technology and approaches to the development of electronic HRM tools;
- distributed design and international technology entrepreneurship;
- professional services and modeling of customer relationship management, in particular under conditions of uncertainty.

In works [31 - 35], some progress has been made in establishing requirements for systems and technologies used for human resource management.

An effective human resource management system must meet a number of administrative, functional and technological requirements to ensure that human resources can be managed efficiently, support partnerships between HR professionals, program managers, finance personnel, managers and employees; while providing accurate, reliable information for planning and decision-making at the organization level [36 - 37].

Studies have shown that more than 90% of HR departments work with a computerized human resource management system [38]. A study conducted by the Institute for Human Resource Studies found that a number of key changes are affecting the use of such systems, including the fact that most HR programs are now networked [39].

Due to the reengineering of business processes and integration of information from various applications, enterprise resource planning has become

popular among organizations. A study [40] found that almost every organization has made significant investments in some combination of enterprise resources, HR service centers, interactive voice response, voice recognition systems, web-based applications, and employee portals.

Many human resource management systems utilize real-time data collection. For example, PeopleSoft's human resource management capabilities were used to track the movements of 5000 employees around the world and allow for accurate calculation of their salaries. Thus, for more effective human resources management, information should be provided as quickly and completely as possible, which allows for the necessary analysis [41 - 43].

In the best administrative systems, human resource management systems are part of software solutions for full-fledged enterprise resource planning. One of the key values of enterprise applications is that they encourage companies to integrate information and organizational processes [44, 45]. Through the advancement of information technology and the development of e-HR, organizations have become more competitive by reducing costs and increasing productivity, quality, and profitability [46]. Modern enterprises and industries are taking appropriate steps to implement IT in the field of human resource management, which allows employees to make their optimal contribution to gaining a competitive advantage [47].

However, at present, there is a low level of integration of software and HRM methods. These methods are not developed and used systematically for human resource management functions in China and Ukraine, and this situation is expected to continue in the near future. In addition, little attention in research has been paid to the use and construction of human resource management methods in extreme conditions, uncertainty and turbulence of the external environment.

There are five social human resource management tools to facilitate the implementation of joint projects [48]:

1. Social scheduling. Project teams can use features such as group calendars to view and organize each other's time, thus increasing productivity. They are

precious when working with interdisciplinary project teams, which may have limited access to each other.

2. Knowledge sharing. Internal social networks allow project teams to share opinions, knowledge, and findings and manage resources and discussion topics related to critical goals and project activities.

3. Training. The company's training department is the traditional source of new knowledge and skills. But while this source can be as rich as ever, social tools allow everyone in the organization to be a source of learning. It can be as simple as an online discussion group or a chat forum.

4. Motivation.

Being recognized for good work can be an incredible motivating force. Old corporate hierarchies limit feedback, motivation, and rewards for work done, which are spread up the chain of command. Some social packages of human resource management systems provide the ability to recommend employees for financial motivation or gratitude for their performance.

5. Non-project challenges. Not all teams and collaborations are project-related. Teams that work together outside of a project assignment tend to perform better overall.

Research in this area is relevant in both Ukraine and China. In China, the relevance is expressed in the rapid economic development and the need to attract personnel with appropriate qualifications; management methods should consider the conditions of market globalization and changes. The relevance for Ukraine is related to the economic crisis and the military conflict, which increases uncertainty. One of the areas that this study focuses on is the development of methods and models for managing human resources of educational projects implemented in the organization of a higher education institution.

1.2. Current state of human resource management systems

At the present stage, human resource management (HRM) systems are undergoing significant transformations under the influence of technological, social

and economic changes. Here are some critical aspects of the current state of HRM systems:

1. Digitalization and information technology (IT). The introduction of digital technologies and IT in HRM allows for automating many processes, such as recruitment, time tracking, HR documents, etc. This contributes to more efficient HR management and increases the accuracy of accounting.

2. Cloud HR and HR analytics. Using cloud technologies in HR allows you to store and process large amounts of personnel data. HR analytics allows one to analyze key performance indicators, forecast personnel development and make informed management decisions.

3. Employee branding. Increased attention to employer branding indicates the importance of creating an attractive employer image. Companies are trying to increase their attractiveness to talented staff through active participation in social networks, corporate event organizations, and creating a positive working atmosphere.

4. Flexible forms of labor. The growing popularity of flexible forms of work, such as remote work, flexible hours, and freelancing, requires adapting HRM systems to new realities. HRM must ensure effective coordination and motivation of teams located in different locations.

5. Leadership and staff development. Modern HR management systems focus on leadership development and emphasize lifelong learning. HR development programs are becoming an essential part of HR strategies.

6. Inclusiveness and diversification. There is a growing awareness of the importance of inclusivity and diversity in the workplace. HRM actively develops strategies to ensure equal opportunities and create a work environment supporting diversity.

7. Cooperation with educational institutions. In today's changing labor market, university HRMs cooperate with companies to create educational programs that meet modern business requirements.

8. Automation of interviews and assessment of professional skills. The use of technologies such as artificial intelligence to automate the selection and assessment of candidates.

Let us consider several examples of human resource management systems and their features. BambooHR [49] is a software designed for small and medium-sized companies. The information about the company's employees in this software is stored in a database, which facilitates the work of an HR specialist to find relevant information about employees.

Employee information and other features are available anytime and anywhere, so an HR professional can access them. HR can also track employee benefits, work and salary history, and performance. For users who need to track other additional data, the system provides for the addition of new particular fields.

BambooHR also has a reporting feature that can generate and send reports quickly. The report library allows users to select pre-generated reports and create reports for sharing. For the practical work of recruiters, an applicant tracking system is integrated with existing BambooHR software. Recruiters can access candidates' resumes, LinkedIn profiles, and job descriptions.

BambooHR supports global capabilities and can adapt to multiple languages and currencies. Another feature is email notifications. BambooHR also supports electronic signatures, which saves time and money on purchasing paper forms. Electronic signatures are protected by enterprise-level encryption and regular security monitoring. A performance management feature also allows companies to provide more frequent feedback on employee performance. The system also includes features such as employee self-assessment and manager evaluation. An additional time tracking module includes daily time recording, employee schedules, and automatic reminders.

The BambooHR system allows you to perform the following essential functions

- importing data about the client's employees (or transferring it from the client's previous system);

- customizing the system, such as email notifications, setting up vacation policies, etc;

BambooHR also provides clients with training opportunities through videos, webinars, and one-on-one training. BambooHR integrates with applications such as Workable, Ximble, GoodHire, Bonusly, Litmos, OfficeVibe, Boomr, and LeverThis. Figures 1.1 and 1.2 show screenshots of the BambooHR system forms in progress.

Let's consider another platform designed to manage potential employees. The system, called ClearCompany [50], is designed to help organizations hire, retain, and attract new employees. The platform targets HR professionals, managers, supervisors, and employees. ClearCompany offers standalone solutions: applicant tracking, employee onboarding platform, and performance management.

Each solution can be integrated with existing company systems, such as ERP or HRIS. ClearCompany integrates with most payroll solutions, especially ADP. ClearCompany also helps companies comply with HR regulations by automating reporting forms. The platform provides opportunities for communication between members of the management team and communication between HR specialists and potential employees.

Charlotte (Char) B Abbott
 Engineering Support
 Full-time · HR · Harrisburg · Finance
 ACTIVE Hired: 02/18/2004

Forms Action

Personal Job **Time Off** Benefits Training Documents Emergency Dependents Notes Driving Assets
 Incidents Onboarding Offboarding

Time Off Record time off

Type	Current Balance	Scheduled Time Off	Available Balance
Bereavement	-7.00	0.00	-7.00 hours Adjust
Compensatory Time	-4.00	0.00	-4.00 hours Adjust
Executive	120.00	0.00	120.00 hours Adjust
PTO	56.00	0.00	56.00 hours Adjust
Sick	48.00	0.00	48.00 hours Adjust

Policies

Name	Accrual Start Date
Exec Vacation	10/06/2011 Remove
Sick Leave	11/03/2010 Remove
Vacation Leave	11/03/2010 Remove
PTO	08/18/2010 Remove

Hire date of 02/18/2004 is used for accrual levels.

Figure 1.1. - Screenshot of the employee's personal page in the BambooHR system

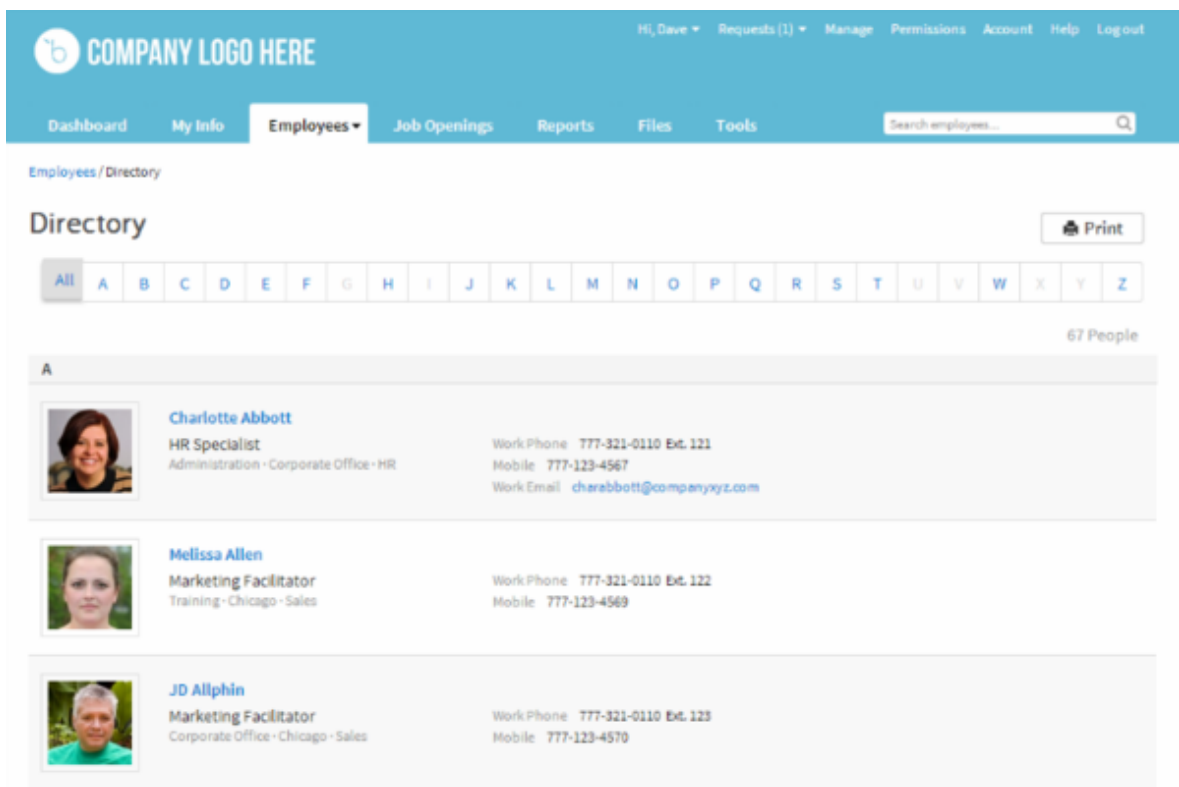


Figure 1.2. - Screenshot of the employee page in the BambooHR system

Performance management decisions are made based on a wide range of performance assessment methods, including peer reviews and methods for evaluating performance over time. The system offers benefits administration features within the platform for HR administrators to manage benefits and employee motivation tasks better.

ClearCompany software has the following features:

1. Analysis of personal business processes. The manager analyzes the client's goals and needs, including any unique requests.
2. Configuration of a particular client account that meets specific needs.
3. Customer service and support teams conduct training designed for the client.
4. ClearCompany software is scalable and flexible.

Figure 1.3 shows screenshots of the ClearCompany system forms in use.

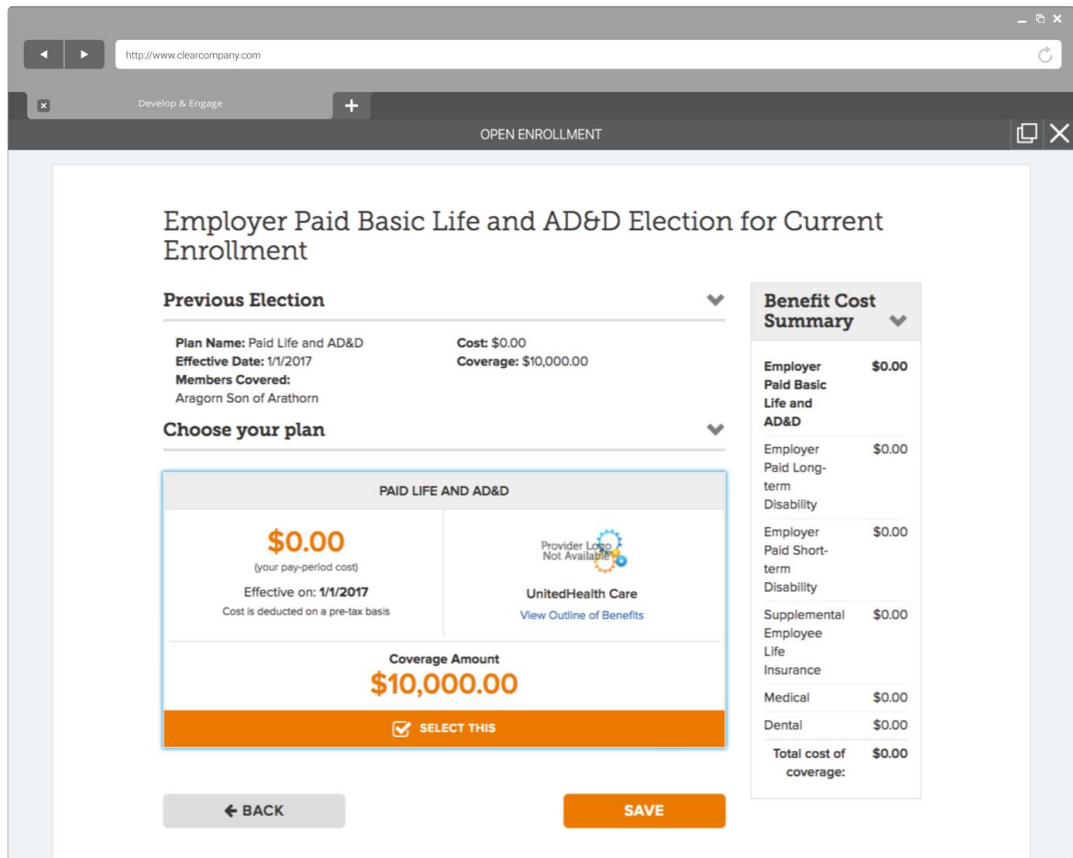


Figure 1.3. - Screenshot of the ClearCompany page

High Line [51] is an integrated human resource management system designed for companies with complex business requirements. It has a modular design, which means that companies can purchase only the components they need. High Line offers solutions in the following main functional areas: human resources, payroll, and employee management. One of the main advantages of the High Line system is that it allows you to customize your solutions based on the unique requirements of the company that uses it. Companies have the ability to add new modules at any time as their needs may grow.

The High Line system addresses the need to work with several different human resource management systems at once, and also allows you to calculate the efficiency and productivity of the company. The High Line system also provides other solutions that may be needed in human resource management, including healthcare, labor relations, pension management, and grant accounting. High Line is deployed in a cloud environment. Additional High Line services include project

planning, training for administrators and users, and user interface customization (Figures 1.4, 1.5).

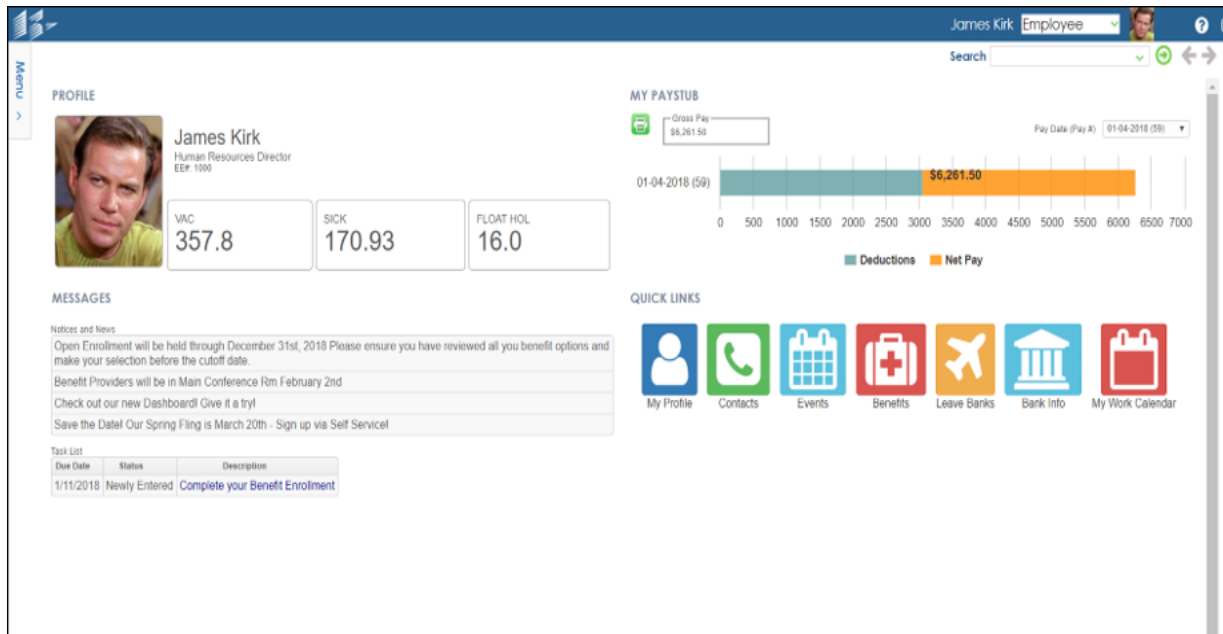


Figure 1.4. Screenshot of an employee's personal page in the High Line software

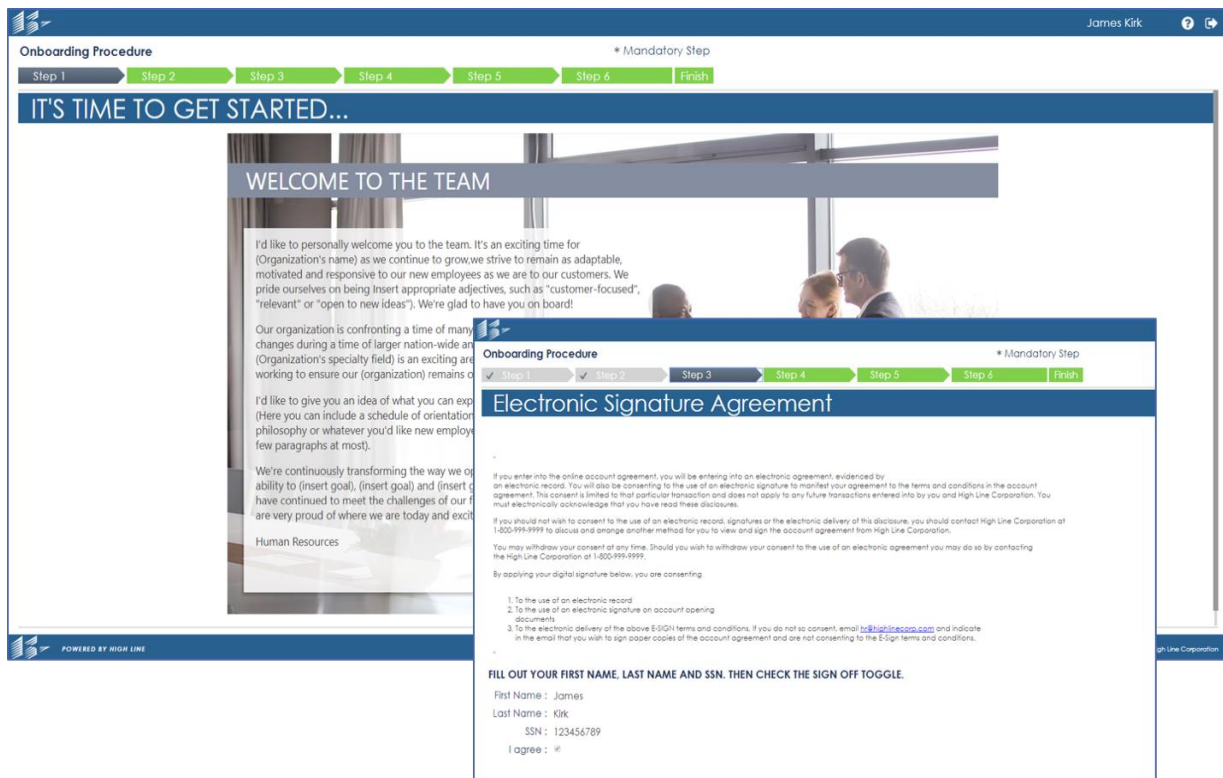


Figure 1.5. - Screenshot of the High Line page

The Kronos Workforce Ready Suite [51] consists of various modules that help companies manage their human resources for hourly employees. The system has several advantages, such as

- automated HR processes, which increases the productivity of HR managers;
- self-service functions for employees and their managers;
- deployment of the system in a cloud environment with access to the Internet and mobile devices;
- strategic focus on employees, performance management and employee motivation modules.

Some of the main features of the Kronos system are: all employee records are stored in a single database, the ability to customize processes for HR tasks such as recruitment, dismissal, job changes, and salary changes, the ability to manage multiple incentive plans, including health insurance, retirement packages, etc., employee training management, and participation in training.

Recruiters in the Kronos system can create job postings, select candidates from multiple databases, and manage workflows. When a new employee is hired, information from their resume is transferred to the HR module. In addition, the Kronos system provides an employee performance management module that supports real-time feedback on employee performance. It includes functions such as individual performance evaluations, setting goals for employees and individual departments, alerts about the schedule of employee performance reviews, etc. Figures 1.6 and 1.7 show screenshots of the system.

Oracle [51] offers two solutions in human resource management: Oracle HCM Cloud and Oracle PeopleSoft. Oracle HCM Cloud is a global human resource management solution for medium and large enterprises. It helps companies manage their core HR tasks and the strategic objectives of the entire organization. Oracle HCM Cloud provides a modern interface that includes all the functions of the employee life cycle. Oracle HCM Cloud simplifies frequent HR tasks with artificial intelligence and machine learning features such as digital assistants and virtual reality.

Oracle HCM Cloud includes the following core modules: strategic workforce planning, recruiting, goal management, performance management, payroll, healthcare solutions, and employee training. Figures 1.8, 1.9 show screenshots of the Oracle HCM system.

So, in general, there are many different kinds of software solutions for human resource management on the market. Some products provide comprehensive management solutions, including flexible employee motivation systems, productivity calculations, health insurance, etc. Some perform local tasks of the HR manager, such as recruiting new employees, etc. These systems can generally be used in the education system to recruit new teachers for the proposed educational programs, but some difficulties prevented from being addressed more efficiently.

The screenshot displays the 'Summary by Employee' page in Kronos Workforce. The interface includes a navigation bar with 'My Reports' selected, and a table listing employee work accounting data for the month of June 2017. The table columns include DATE, SCHEDULE NAME, APPROVAL STATE, START, END, TOTAL SCHEDULED HOURS, START-STOP, SHIFT TYPE, SKILL, DEPARTMENTS, and TIME OFF HOURS. Data is grouped by employee, with subtotals for each.

DATE	SCHEDULE NAME	APPROVAL STATE	START	END	TOTAL SCHEDULED HOURS	START-STOP	SHIFT TYPE	SKILL	DEPARTMENTS	TIME OFF HOURS
Full Name: Alice Fortune Ungroup										
06/01/2017	MFG - Freddy's Employees	Posted	03:00p	11:00p	8.00	03:00p - 11:00p	Fixed	Shipping	Receiving	
06/02/2017	MFG - Freddy's Employees	Posted	03:00p	11:00p	8.00	03:00p - 11:00p	Fixed	Shipping	Receiving	
Subtotal (Full Name: Alice Fortune)					16.00					
Full Name: Allen Scott Ungroup										
06/01/2017	MFG - Freddy's Employees	Posted	03:00p	11:00p	8.00	03:00p - 11:00p	Fixed	Forklift	Fork Lift Operator	
06/02/2017	MFG - Freddy's Employees	Posted	03:00p	11:00p	8.00	03:00p - 11:00p	Fixed	Forklift	Fork Lift Operator	
Subtotal (Full Name: Allen Scott)					16.00					
Full Name: Arthur Gee Ungroup										
06/01/2017	MFG - Freddy's Employees	Posted	08:00a	06:00p	10.00	08:00a - 06:00p	Fixed	Shipping	Receiving	
Subtotal (Full Name: Arthur Gee)					10.00					
Full Name: Bimbaum Jakob Ungroup										
06/01/2017	MFG - Freddy's Employees	Posted	03:00p	11:00p	8.00	03:00p - 11:00p	Fixed	Packaging Assembly	Packing	
Subtotal (Full Name: Bimbaum Jakob)					8.00					
Full Name: Bob Brooks Ungroup										
06/01/2017	MFG - Freddy's Employees	Posted	08:00a	06:00p	10.00	08:00a - 06:00p	Fixed	Assistant Manager	Assistant Manager	
06/02/2017	MFG - Freddy's Employees	Posted	08:00a	06:00p	10.00	08:00a - 06:00p	Fixed	Assistant Manager	Assistant Manager	
Subtotal (Full Name: Bob Brooks)					20.00					

Figure 1.6. - Screenshot of employee work accounting in Kronos Workforce

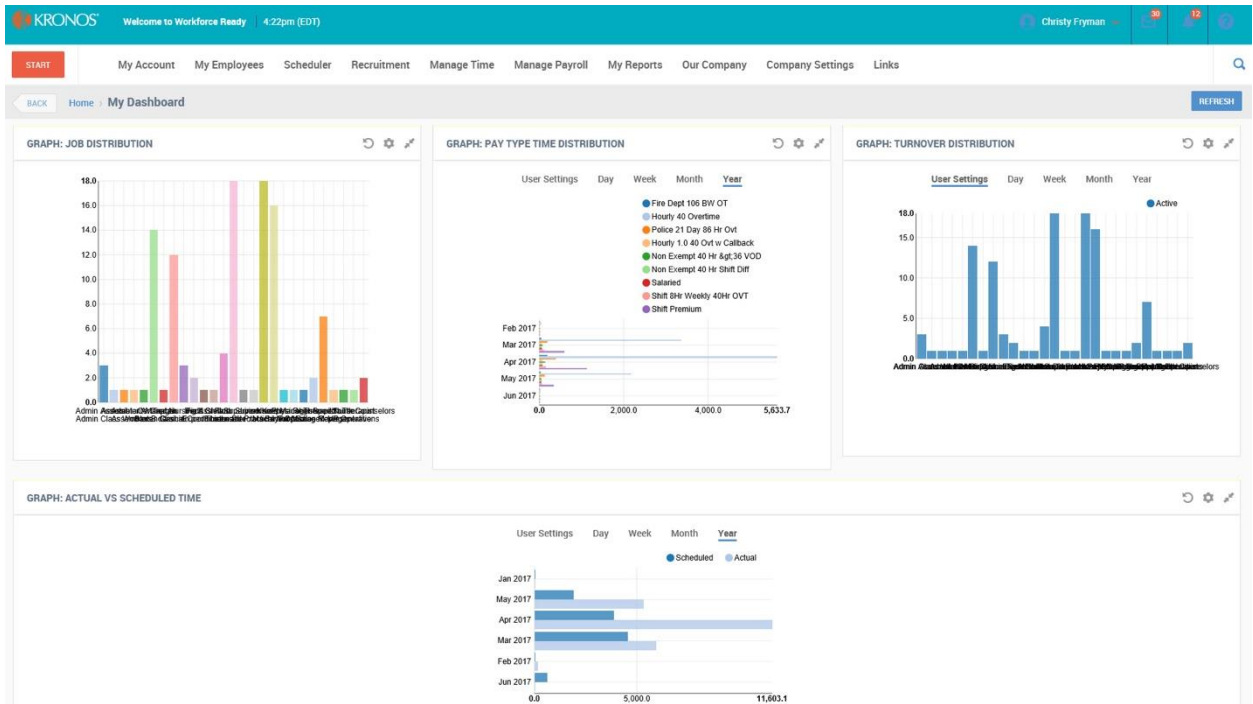


Figure 1.7. - Screenshot of the dashboard page in Kronos Workforce

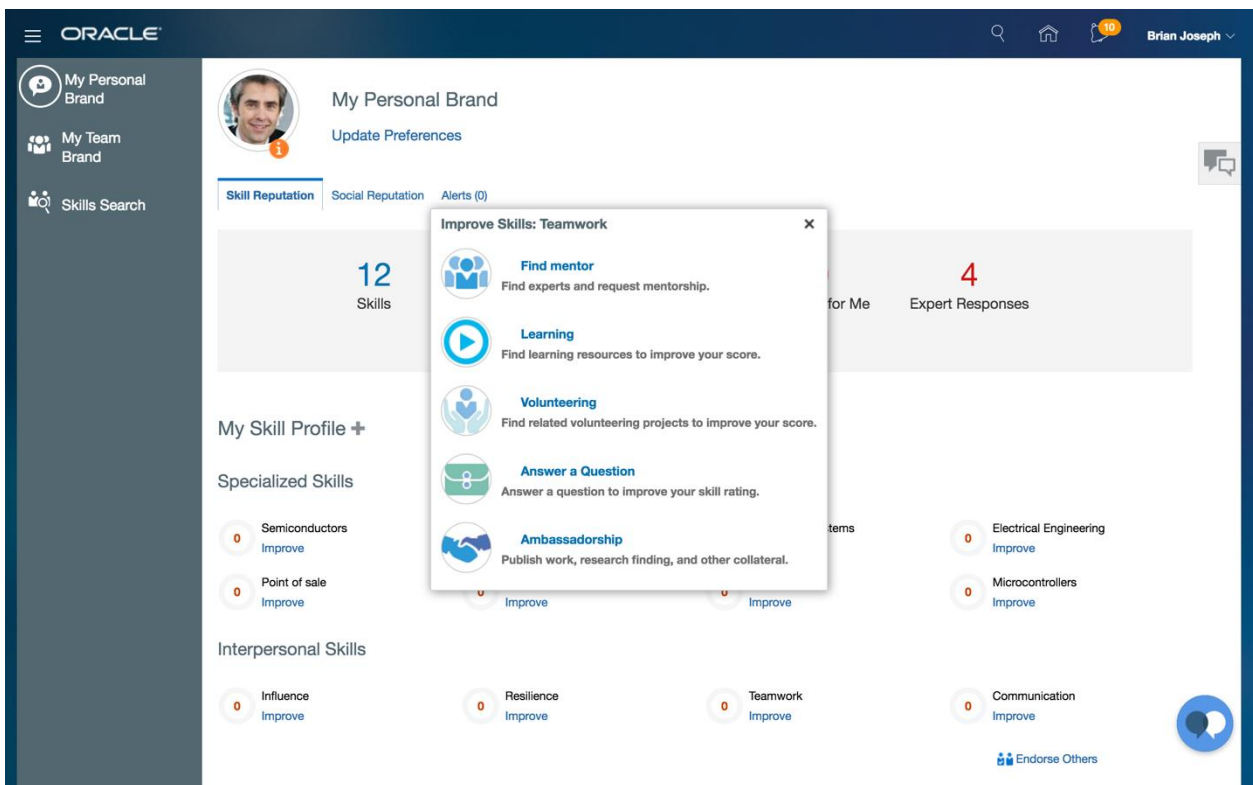


Figure 1.8.- Screenshot of a personal page in Oracle HCM

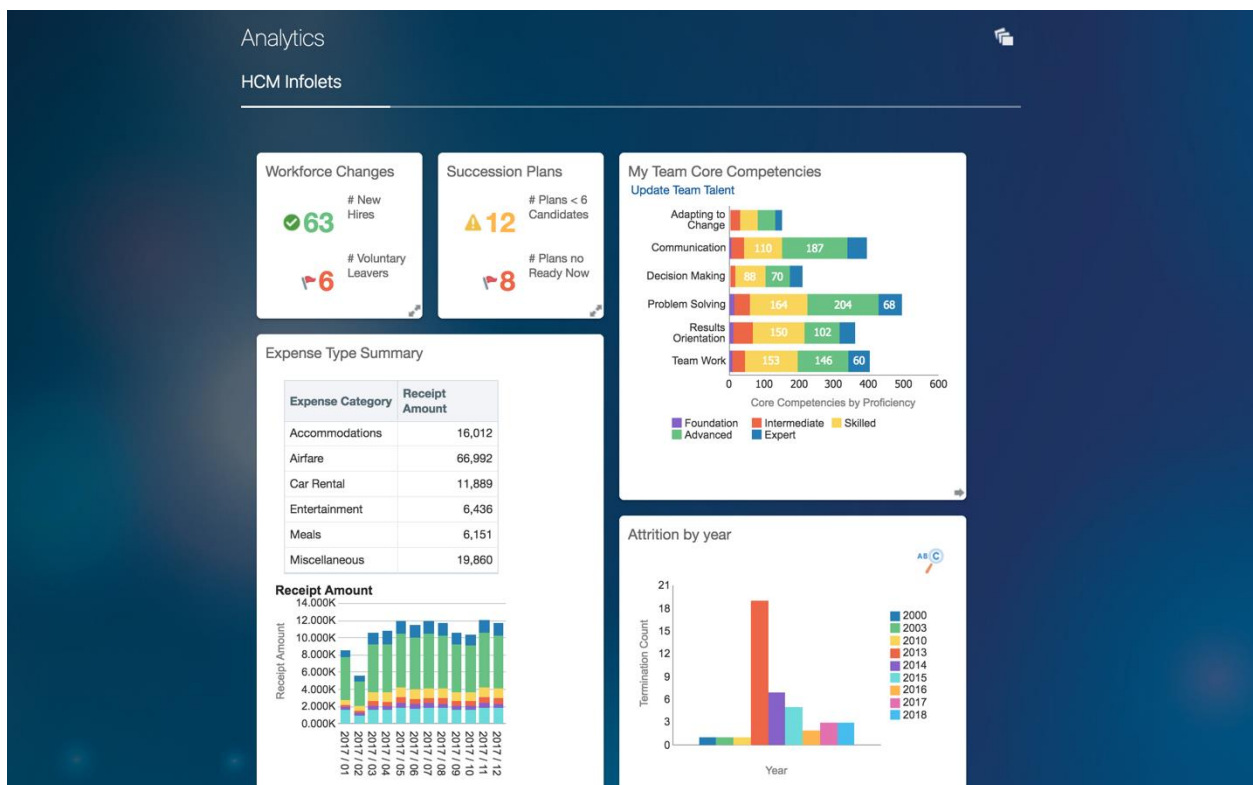


Figure 1.9. - Screenshot of the analytics page in Oracle HCM

The use of these products for organizing educational projects is complicated because productivity is mainly calculated in these systems by the number of hours worked, which is more suitable for factory production. In education, however, the productivity of employees should be assessed more complexly, as it is based on intellectual achievements, developed training modules, the quality of student learning, etc. In addition, such systems do not consider the special possible conditions of companies' operations, such as COVID-19, military conflicts and other kinds of environmental turbulence, i.e. the systems do not have the necessary adaptability. In these conditions, recruiting new employees and evaluating their performance occurs under uncertain conditions, which must be considered. To take these conditions into account, it is necessary to build mathematical models and integrate them into the HR management system.

1.3. Principles and methods of human resource management in educational projects

For better understanding, here is a definition of what will be meant by the term "educational project" in this paper. An educational project is an initiative or program aimed at achieving specific educational goals or solving educational problems. This can be a wide range of ideas, from developing a new course or teaching methodology to creating an educational institution or reforming an existing education system. In this paper, we will consider the localization of this concept. That is, an educational project will be understood as a project whose main goal is to solve educational problems, including student training, development of teaching and learning materials, etc.

In general, educational projects can be implemented at different levels, such as school, university, regional, or national. They can be aimed at developing new skills and competencies of students, improving the quality of learning and teaching, introducing innovative approaches to the learning process, developing technologies in education, etc. In this paper, the educational project will be considered at the university level, and therefore its characteristics and composition will relate to the university education system.

It should also be understood that educational projects can combine the efforts of various organizations, including educational institutions, government agencies, non-profit organizations, and partners from various private companies. The main goal of educational projects is to improve the quality of education and prepare students for the challenges of the modern world.

Let's look at some of the features of human resource management in educational projects. Some of them are standard and apply to all projects without exception. In particular, human resource management is based on a number of principles that are key and cannot be violated: maintaining a sense of self-respect and value for the team, focusing on tasks and problems rather than individuals, providing feedback support and active action on employee responses. It should be

noted that some countries have certain differences in human resource management. More details are described in the matrix of human resource management features (Table 1.1) [52].

Table 1.1. Matrix of features of human resource management in some countries resources management in some countries

Tools	Japan	Germany	Mexico	China
Selection of employees	the selection process is lengthy; employees are motivated to stay with the company; development of trusting relationships with new employees	attracting the best employees who have been trained under state training programs	intensive use of expatriates; recruitment of Mexican college graduates from the United States	the latest government policy supporting the use of thorough selection procedures
Training	making serious investments in training; use of general training and cross-cultural training	use of apprenticeship programs; state regulation of training	use of bilingual trainers	Careful study of existing training programs; use of team training
Remuneration and motivation	use of recognition and rewards as a motivator	taking into account high labor costs in production	Consideration of all aspects of labor costs	using technical training as a reward; recognizing equal values
Labor relations	relations with trade unions as partners; time for negotiations is provided	readiness for high salaries and short working weeks; expectation of high productivity	Understanding the changes in Mexican labor law; preparing for the growing level of employee unionization	formation of cities with large labor markets; labor legislation is gradually becoming stricter

Tools	Japan	Germany	Mexico	China
Service design	creation of autonomous working teams; use of uniforms and formal approaches; support for group efforts; strengthening decision-making teams	use of works councils to improve the quality of employee engagement in management	warnings regarding the participation of employees in management	determining the motivation of employees to implement employee participation in management

Four primary forms of staff incentives are considered:

1. Material benefit, which is the basis that ensures labor productivity.
2. Specific tools for motivating employees.
3. Intangible incentives are classic forms of employee motivation without material rewards (gratitude, awards, incentives, new job, early promotion).
4. Mixed motivation uses combined (tangible and intangible) incentives.

In modern practice, there are three main career models: American, European and Japanese. The American model includes:

- Higher education.
- Little practical experience.
- Higher management training before starting a career at a university business school and obtaining an MBA (Master of Business Administration).
- After obtaining an MBA, business career is based on invitations from corporations and business schools.

The European model includes:

- Higher education.
- Acquisition of managerial knowledge and skills based on practical work in managerial positions.

- Systematization and improvement of managerial skills in the process of retraining and advanced training at leading university business schools.

The Japanese model includes:

- Higher education,.
- Competitive recruitment to a corporation,.
- A career as a specialist with promotion to a managerial position, and.
- Multi-stage rotation combined with retraining and advanced training in corporate training centers.

There are also several barriers to international communication: language barriers, perception barriers, cultural peculiarities, and non-verbal communication.

Ways to improve the effectiveness of communication include:

- Improving the feedback system.
- Conducting language training.
- Ensuring flexibility of cooperation.
- Cultural training.

To build an effective human resource management system, it is necessary to conduct an organizational and management analysis, which includes an analysis of the company's goals, an analysis of the organizational structure, an analysis of management processes, and an information exchange structure. When applied to educational projects, the following organizational and managerial analysis sequence can be set (Table 1.2).

If the results of the analysis reveal shortcomings, an organizational engineering procedure can be carried out. Organizational engineering is a management approach that aims to optimize the structure and processes of an organization to improve efficiency and effectiveness. This term can be used in various contexts, including business, manufacturing, administration, and other areas of activity.

Table 1.2 Components of organizational and managerial analysis of educational projects

Areas of analysis	Contents
Analysis of the system of educational project goals and strategies for achieving them	Identification and analysis of the university's mission in the context of the relevant educational project, as well as the limitations of these goals and the possibilities of achieving them
Analysis of the organizational structure of an educational project	Study of the existing organizational and structural units and their interrelationships of the educational project in the context of the university organizational structure
Analysis of educational project management processes	Identification, modeling, and analysis of processes designed to achieve the goals of an educational project
Analysis of the structure of information transmitted in the implementation of educational project goals	Analysis and structuring of information that circulating in the educational project, means of transmission, etc.

The main stages of organizational engineering of an educational project may include:

1. Analysis of the current state of the educational project: studying the existing structures, processes, and systems in the organization to identify weaknesses and opportunities to improve mechanisms for achieving the goals of the educational project.
2. Strategy development: defining goals and strategies to achieve improvements in meeting the goals of the educational project.
3. Designing a new structure: creating the optimal organizational structure of the educational project, including the distribution of responsibilities,

powers and communication chains between the executors of the educational project.

4. Implementation of changes in achieving the goals of the educational project.

5. Determining the effectiveness of the implemented changes and adjusting strategies to achieve the results of the educational project, if necessary.

Organizational engineering of an educational project may include the use of tools and methods, such as project management, business process modeling, technology audit, and others, to maximize the efficiency of management practices and the use of educational project resources. This approach can be used to solve efficiency problems, reduce costs, improve the quality of products or services, and adapt the organization to changes in the external environment.

Different methods are used to solve the problems of human resource management in educational projects. In particular, the problem of satisfying constraints can be formulated as a system of equations with numerical parameters, and standard numerical methods can be used to solve it. However, when solving many real-world problems, especially if the model includes non-numerical parameters and the initial data is specified in the form of sets and intervals containing valid values, these methods are not applicable.

One of the most developed and practically significant approaches to solving the problems of human resource management in educational projects is the so-called underdetermined computational models. They consist in the use of mathematical or computational models that operate with variables that are not precisely defined or specific. This may include uncertainty in the input data, parameters, or the modeling itself.

One of the branches related to this topic is the theory of fuzzy sets, which allows for the representation and handling of uncertainty and fuzziness in data. In fuzzy models, elements can belong to sets partially rather than completely, and they can have degrees of membership that determine the degree of fuzziness. Another approach is to use probabilistic models or the Bayesian approach, where

instead of exact values of input data, we work with probability distributions that reflect uncertainty or lack of complete information.

Also, models can be used that make assumptions or rely on approximations in cases where precise information is difficult to obtain or not available at all. Uncertainty-based computational models can be useful in situations where there is uncertainty about parameters or conditions, and where decisions or predictions need to be made with limited information. When applied to educational projects, this class of methods is the most commonly used, as many of the parameters for tasks in such projects are verbalized or qualitatively rather than quantitatively. There is also a certain degree of uncertainty in the tasks of such projects due to the possible turbulence of the environment [54-57].

The general underdetermined computational set model has the form:

$$M=(K,L,R,C), \quad (1)$$

where K – values of objects from the specified area, L – constraints that are set on the set of objects K , R – objective functions, C – functions for checking the correctness. Depending on the task, sets can be specified.

At the level of interpretation, the undefined computational set model is a bipartite oriented graph [58, 59], with two types of vertices: functions and objects. Arcs connect object and function nodes. Objects with values as input arguments to a function are correlated with the input to the vertex-function of the arc. An integer is associated with each function node. It performs the function of priority, marking the input and output arcs. The priority indicates the order of traversal of functions in the calculation process.

The following statements were proved in [60]:

- the process of satisfying constraints in an underdetermined computational model is completed in a finite number of steps;
- whether the process fails or succeeds is determined by the input data (initial uncertain values of variables and constraints) and does not depend on a specific strategy for choosing the next constraint to be interpreted;

- in case of success of the process with the same input uncertain values of variables, their output uncertain values do not depend on a specific strategy of choosing the next constraint for interpretation.

Compared to the use of the classical mathematical apparatus of scenario analysis of projects, the proposed problem statement allows: taking into account any constraints regardless of their complexity and the nature of the input parameters; planning calculations with inaccurate and incomplete information; obtaining sets of project implementation options; optimizing the project according to any selected criterion without using heuristics.

The principles of educational project management can be considered from different angles and with varying degrees of detail. Works [61-90] describe various methods of organizing, planning, and managing educational projects that may be required when developing appropriate human resource management software. In particular, in the context of educational project management, these works often use a competency-based approach, that is, the emphasis in management is not on the task, but personally on the employee's capabilities, his or her competencies, which are the basis for the quality performance of this task.

There is an opinion that public institutions and organizations, including in the field of providing educational services, are less productive and have a more inflated budget than private institutions that are managed based on performance and take into account real profits [91]. The human factor plays a vital role in the effectiveness of activities and the use of the budget. That is, the more professional environment is formed in the institution, the more influential the results of this institution will be. An essential component of the formation of a professional environment in an institution, in particular in an institution of higher education, is the presence of proactive motivation among employees [92, 93].

Expectancy theory explains why many workers are unmotivated and only fake work or at least put in minimal effort to achieve results, even when they receive high rewards. An important influence on employee performance is exerted by:

- professional working environment [94];
- leadership [95];
- job satisfaction [96];
- sufficient remuneration [97];
- career development [98].

In the last few decades, the development of technology has significantly changed the processes and practices of human resource management. A new direction of research has appeared: information systems of human resources. This direction develops tools and methods for solving tasks and problems managing human resources in various conditions. At the same time, methods of obtaining, presenting, storing, manipulating, and analyzing data about human resources in some organizations for personnel management and decision-making support are considered. The work [99] describes the peculiarities of this research direction. In works [100, 101], this area is considered more broadly and includes not only training and selection of potential employees and their compensation but also automation of salary calculation, etc. This expansion allows us to talk about the direction of electronic human resource management (eHRM). It includes the possibilities of using cloud technologies, self-service technologies and distance learning, which allow to more efficiently and quickly solve a whole layer of tasks related to managing human resources in organizations. The development of information technologies for the electronic management of human resources is especially relevant in critical conditions: conditions associated with the pandemic and military operations in Ukraine and other parts of the world.

However, the analysis of recent studies needs to be more accurate in the direction of the development of information technologies for human resources management, particularly electronic management. The studies are incomplete and do not consider the special conditions of the organization's functioning. At the same time, the interest of the private sector in the development of this direction is growing every year. In the studies conducted on the edge of the technological leap of the early 90s of the last century [102], the analysis of changes in human

resource management practices is little followed. However, it exerts a critical influence on the development of methods, models, and means of their implementation and, in the long run, can significantly improve efficiency in solving several tasks of human resources management.

There are different interpretations of problems that are solved within the new directions of human resources management. One of the first definitions of eHRM was conducting human resource operations over the Internet [100]. Others defined eHRM as implementing HR practices using web technologies [103]. In [104], eHRM was described as a mechanism by which organizational stakeholders, particularly managers, job candidates or employees, access HR information and functions via the Internet [105].

Until recently, the development of technologies in human resource management has been based on the development of decision support systems and ERP systems for human resource management. The following leading vendors should be highlighted: SAP, Oracle, and PeopleSoft. At present, the dominant influence on the development of this direction is exercised by:

- implementation of cloud technologies for human resources management (leading vendors: Workaday, Success Factors);
- development of data analytics and Big Data to support decision-making in human resources management;
- use of mobile technologies, in particular applications and systems;
- social resources used to select potential employees of the organization.

Thus, the main directions for research related to the application of information technologies for human resource management in general and their adaptation to unique or critical conditions of operation are especially relevant. It is also essential to develop models, methods and tools for resource management of specific organizations, in particular higher education institutions that have certain features, as well as educational projects that operate in these institutions and require the practical application of human resources management technologies.

At the same time, during the construction of information technology for the management of human resources of educational projects, related tasks also arise, in particular, the task of monitoring the scientific productivity of employees of higher education institutions [106, 107], the task of selecting potential executors of educational projects [108, 109] and, in general, the task of managing educational projects and programs [110, 111].

That is, in addition to the conditions of environmental turbulence and the peculiarities of assessing the productivity of achieving the goals of educational projects, which have a significant share of qualitative parameters, another condition can be identified that allows to increase the effectiveness of human resource management in educational projects. This condition relates to focusing on the competencies of the educational project implementers. If we are talking about a regular project without an educational component, the main thing here is to focus on achieving the tasks that lead to the fulfillment of the project goals. If we are talking about implementing an educational project, the main thing is the competence of the project implementers, which, in case of insufficiency, can be ensured by appropriate certification through training. Moreover, as already mentioned, the competency-based approach to managing an educational accession in the current environment is complicated by the assessment of productivity, as the latter has many factors of influence and is difficult to quantify. Also, a competency-based approach should take into account possible turbulence in the external environment (military conflict, pandemic, economic crisis), etc. Accordingly, before building a human resource management system based on this approach, it is necessary to develop a mathematical methodological framework that would improve existing tools or create new approaches to effective human resource management. The existing mathematical framework is not enough for this. The main provisions stated in this section and developed in the following chapters of the dissertation are described in [112-122].

Conclusions to chapter 1

1. The paper analyzes and establishes that there are gaps in the development of human resource management information technologies, in particular e-governance, research is fragmented and practically does not take into account the special conditions of the organization's functioning and external undesirable influences: pandemic, economic crisis, military conflict. At the same time, the private sector's interest in developing this area is growing every year. Thus, the main areas for research relate to the use of information technology for human resource management tasks in general, and their adaptation to special or critical operating conditions is especially relevant.
2. The principles and methods of human resource management are presented, and the shortcomings of existing methods are indicated. In the context of the results obtained, it is proposed to improve existing mathematical tools and develop new ones to ensure the effective implementation of educational projects in the field of human resource management.
3. The current state of development of human resource management systems is analyzed, and a review of well-known systems is carried out. It is established that these well-known tools cannot be effectively used for the task of managing human resources of educational projects due to their specificity: it is difficult to assess the productivity of project implementers (qualitative assessments are available, productivity is influenced by many factors), it is difficult to achieve the goals of an educational project in conditions of change and uncertainty, when the external environment is turbulent (military conflict, pandemic), in the context of educational transformation, competency-based methods must have an adaptive property and adapt to the

4. The obtained results are important for ensuring the impartial formation of the project team and human resource management, in particular on the basis of competency-based methods. The results are important for higher education institutions and project managers, including educational and scientific ones.

CHAPTER 2. CONCEPTUAL MODEL OF HUMAN RESOURCE MANAGEMENT OF EDUCATIONAL PROJECTS

2.1. A multiple model of the life cycle of an educational project

As mentioned in the previous section, an educational project is a program that is created and implemented to achieve educational goals and objectives. The multiple model of the educational project life cycle defines the different stages and phases of the development of an educational project from its inception to completion. This model takes into account the various aspects and factors that affect the project and allows you to manage it at different stages. The main stages of the educational project life cycle are:

1. Planning.
2. Project development.
3. Implementation of the educational project.
4. Operation and support.
5. Evaluation and improvement.

Planning an educational project includes two main stages:

- Determining the purpose of the project, including the definition of specific goals and objectives that the educational project should address;
- determining the resources needed to implement the project, including financial, human resources, equipment, etc.

Project development involves creating educational content, developing curricula and necessary teaching materials, and providing technical support, including the development of technical tools, which may include websites, learning platforms, software, etc.

The next stage in the life cycle of an educational project is project implementation, which includes the actual launch of the educational project and the start of the learning process, as well as performance evaluation (determining how well the project is being implemented and whether it is achieving its goals).

After the implementation, requirements are formed to ensure the stable operation of the educational project, solve problems, and provide support to users and project participants.

The next step is to ensure the evaluation and continuous improvement of the educational project. It includes directly evaluating the project results and comparing them with the original goals, making changes and improvements based on the data obtained to improve the quality and effectiveness of the project. These two stages can be combined together. However, if changes need to be made to the project, the project is sent to the development stage and goes through the cycle again until implementation and evaluation. The last stage is project completion.

Let $U = (U_1, U_2, \dots, U_m)$ is a list of universities that are implementing some educational projects, m is the number of universities. Then we denote by

$$\Theta^i = (O_1^i, O_2^i, \dots, O_{n_i}^i) \quad (2)$$

- educational projects that are being implemented or have been implemented at the university U_i , $i = \overline{1, m}$, n_i - number of educational projects at the university U_i . Projects that have already been completed are also recorded, as their number and scores can be used to assess the productivity of universities. We also define a discrete time $T = (t_0, t_1, \dots, t_r)$,

and assume that educational projects transform over time and move from one state to another. Let's define the following states:

1. Planning stage (E_p).
2. Development stage (E_d).
3. Implementation stage (E_w).
4. Operation and maintenance phase (E_s).
5. Completion stage (E_x).

At any given time $t_k \in T$ Each educational project belongs to one of the stages (life cycle states), and at certain points in time, the educational project

transitions from one state to another. The first stage (planning stage) is the initial stage, i.e., the project is not in any state before this stage. The last state (the completion stage) is the final state, that is, the project does not move to another state after this state. All projects that belong to this state are the project history of the university and can be used for its evaluation (Fig. 2.1). Projects can move between the stages of development, implementation, and operation and support. That is, if a project at the operation and support stage needs to be clarified, it goes to the development stage and is improved, and then implemented and operated (Fig. 2.2). If the project cannot be improved, the project is transferred to the completion stage and a new project is created at the planning stage.

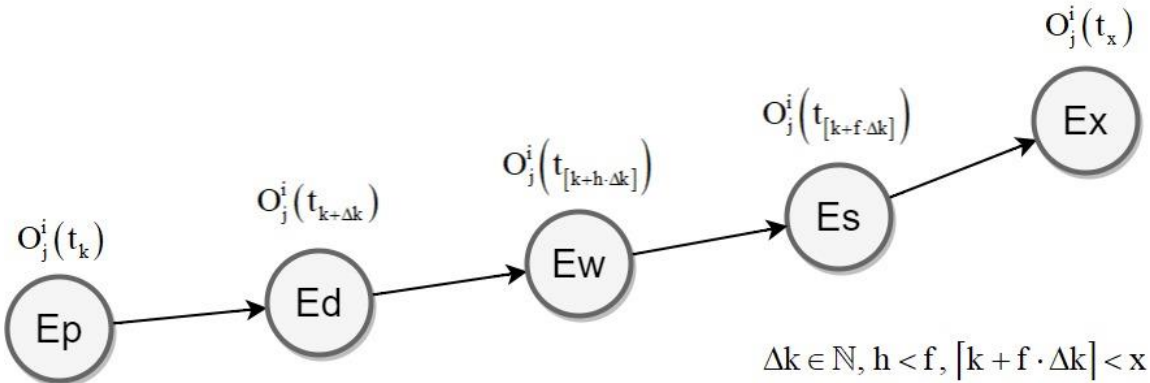


Figure 2.1 - Diagram of the stages of the life cycle of educational projects and their transformation

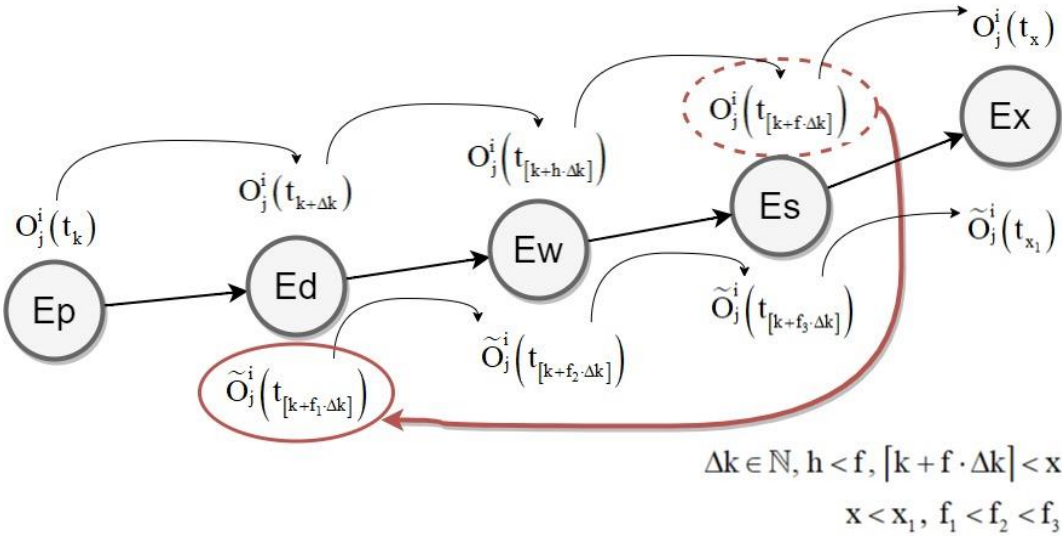


Figure 2.2. - Scheme of project transition between life cycle stages and improvement of an educational project

That is, the university U_i , $i = \overline{1, m}$ at a point in time $t_k \in T$ is determined by the profile of educational projects that are being implemented or have been implemented by the time t_k , that is, they were implemented in the time period $[t_0, t_k]$. The profile of the university's educational projects is defined by five tuples: $O^i(E_p, t_k) = (O_{j_1^p}^i, O_{j_2^p}^i, \dots, O_{j_p^p}^i)$, $j_{b_1}^p \in \{1, 2, \dots, n_i\}$, $b_1 = \overline{1, p}$, the upper index above the letter j indicates that projects are at the stage of E_p .

1. $O^i(E_d, t_k) = (O_{j_1^d}^i, O_{j_2^d}^i, \dots, O_{j_d^d}^i)$, $j_{b_2}^d \in \{1, 2, \dots, n_i\}$, $b_2 = \overline{1, d}$, the upper index above the letter j indicates that projects are at the stage of E_d .

2. $O^i(E_w, t_k) = (O_{j_1^w}^i, O_{j_2^w}^i, \dots, O_{j_w^w}^i)$, $j_{b_3}^w \in \{1, 2, \dots, n_i\}$, $b_3 = \overline{1, w}$, the upper index above the letter j indicates that projects are at the stage of E_w .

3. $O^i(E_s, t_k) = (O_{j_1^s}^i, O_{j_2^s}^i, \dots, O_{j_s^s}^i)$, $j_{b_4}^s \in \{1, 2, \dots, n_i\}$, $b_4 = \overline{1, s}$, the upper index above the letter j indicates that projects are at the stage of E_s .

4. $O^i(E_x, t_k) = (O_{j_1^x}^i, O_{j_2^x}^i, \dots, O_{j_x^x}^i)$, $j_{b_5}^x \in \{1, 2, \dots, n_i\}$, $b_5 = \overline{1, x}$, the upper index above the letter j indicates that projects are at the stage of E_x .

If $E = \{E_p, E_d, E_w, E_s, E_x\}$ - is the set of all stages of the life cycle of educational projects, then $\Theta^i = \bigcup_{e \in E} O^i(e, t_k)$, Θ^i - does not depend on time.

Let's look at the cases that can occur in the system of educational projects in the life cycle:

1. 1. Transition of an educational project from the state of E_s into a state of E_d (Fig. 2.2.)
2. 2. Completion of the project, i.e., bringing the project to a state of E_x (fig. 2.3).
3. 3. Start planning a new educational project, i.e. adding a new project to

the E_p (fig. 2.4.).

Case 1.

If at the moment of time $t_{k+1} \in T$ for the university U_i , $i = \overline{1, m}$ is an educational project $O_{j_y}^i$, that is in a state of operation and maintenance requires some changes, then the profile of the university's educational projects will be defined as follows:

$$1. \quad O^i(E_p, t_{k+1}) = (O_{j_1^p}^i, O_{j_2^p}^i, \dots, O_{j_{b_1}^p}^i), \quad j_{b_1}^p \in \{1, 2, \dots, n_i\}, \quad b_1 = \overline{1, p},$$

the upper index above the letter j indicates that projects are at the stage of E_p .

$$2. \quad O^i(E_d, t_{k+1}) = (O_{j_1^d}^i, O_{j_2^d}^i, \dots, O_{j_{b_2}^d}^i, O_{j_{d+1}^d}^i = O_{j_y}^i), \quad j_{b_2}^d \in \{1, 2, \dots, n_i\},$$

$b_2 = \overline{1, d+1}$, the upper index above the letter j indicates that projects are at the stage of E_d .

$$3. \quad O^i(E_w, t_{k+1}) = (O_{j_1^w}^i, O_{j_2^w}^i, \dots, O_{j_{b_3}^w}^i), \quad j_{b_3}^w \in \{1, 2, \dots, n_i\}, \quad b_3 = \overline{1, w},$$

the upper index above the letter j indicates that projects are at the stage of E_w .

$$4. \quad O^i(E_s, t_{k+1}) = (O_{j_1^s}^i, O_{j_2^s}^i, O_{j_{y-1}^s}^i, O_{j_{y+1}^s}^i, \dots, O_{j_s^s}^i), \quad j_{b_4}^s \in \{1, 2, \dots, n_i\}, \quad b_4 = \overline{1, s},$$

$b_4 \neq y$, the upper index above the letter j indicates that projects are at the stage of E_s .

$$5. \quad O^i(E_x, t_{k+1}) = (O_{j_1^x}^i, O_{j_2^x}^i, \dots, O_{j_k^x}^i), \quad j_{b_5}^x \in \{1, 2, \dots, n_i\}, \quad b_5 = \overline{1, x},$$

the upper index above the letter j indicates that projects are at the stage of E_x .

Adding an educational project to the second tuple $O_{j_{d+1}^d}^i = O_{j_y}^i$, while removing it from the fourth tuple.

Case 2.

If at the moment of time $t_{k+1} \in T$ for the university U_i , $i = \overline{1, m}$ is an

educational project $O_{j_y}^i$, that is in the state of operation and maintenance can no longer be continued, it is removed from the cycle, including in the tuple E_x , i.e.

1. $O^i(E_p, t_{k+1}) = (O_{j_1^p}^i, O_{j_2^p}^i, \dots, O_{j_p^p}^i)$, $j_{b_1}^p \in \{1, 2, \dots, n_i\}$, $b_1 = \overline{1, p}$, the upper index above the letter j indicates that projects are at the stage of E_p .

2. $O^i(E_d, t_{k+1}) = (O_{j_1^d}^i, O_{j_2^d}^i, \dots, O_{j_d^d}^i)$, $j_{b_2}^d \in \{1, 2, \dots, n_i\}$, $b_2 = \overline{1, d}$, the upper index above the letter j indicates that projects are at the stage of E_d .

3. $O^i(E_w, t_{k+1}) = (O_{j_1^w}^i, O_{j_2^w}^i, \dots, O_{j_w^w}^i)$, $j_{b_3}^w \in \{1, 2, \dots, n_i\}$, $b_3 = \overline{1, w}$, the upper index above the letter j indicates that projects are at the stage of E_w .

4. $O^i(E_s, t_{k+1}) = (O_{j_1^s}^i, O_{j_2^s}^i, O_{j_{y-1}^s}^i, O_{j_{y+1}^s}^i, \dots, O_{j_s^s}^i)$, $j_{b_4}^s \in \{1, 2, \dots, n_i\}$, $b_4 = \overline{1, s}$, $b_4 \neq y$, the upper index above the letter j indicates that projects are at the stage of E_s .

5. $O^i(E_x, t_{k+1}) = (O_{j_1^x}^i, O_{j_2^x}^i, \dots, O_{j_x^x}^i, O_{j_{x+1}^x}^i = O_{j_y^s}^i)$, $j_{b_5}^x \in \{1, 2, \dots, n_i\}$, $b_5 = \overline{1, x+1}$, the upper index above the letter j indicates that projects are at the stage of E_x .

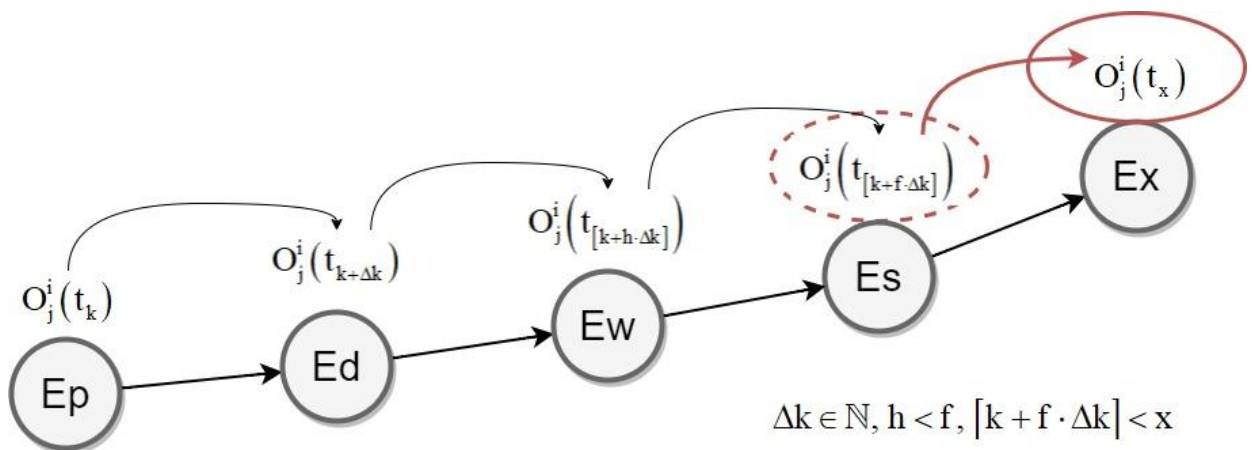


Figure 2.3 - Scheme of completion of a project that is in operation

Case 3.

If at the moment of time $t_{k+1} \in T$ for the university U_i , $i = \overline{1, m}$ it is

necessary to start planning a new educational project O^i , it is included in the tuple E_p , i.e.:

1. $O^i(E_p, t_{k+1}) = (O_{j_1^p}^i, O_{j_2^p}^i, \dots, O_{j_p^p}^i, O_{j_{p+1}^p}^i)$, $j_{b_1}^p \in \{1, 2, \dots, n_i\}$, $b_1 = \overline{1, p+1}$.
2. $O^i(E_d, t_{k+1}) = (O_{j_1^d}^i, O_{j_2^d}^i, \dots, O_{j_d^d}^i)$, $j_{b_2}^d \in \{1, 2, \dots, n_i\}$, $b_2 = \overline{1, d}$.
3. $O^i(E_w, t_{k+1}) = (O_{j_1^w}^i, O_{j_2^w}^i, \dots, O_{j_w^w}^i)$, $j_{b_3}^w \in \{1, 2, \dots, n_i\}$, $b_3 = \overline{1, w}$.
4. $O^i(E_s, t_{k+1}) = (O_{j_1^s}^i, O_{j_2^s}^i, \dots, O_{j_s^s}^i)$, $j_{b_4}^s \in \{1, 2, \dots, n_i\}$, $b_4 = \overline{1, s}$.
5. $O^i(E_x, t_{k+1}) = (O_{j_1^x}^i, O_{j_2^x}^i, \dots, O_{j_x^x}^i)$, $j_{b_5}^x \in \{1, 2, \dots, n_i\}$, $b_5 = \overline{1, x}$.

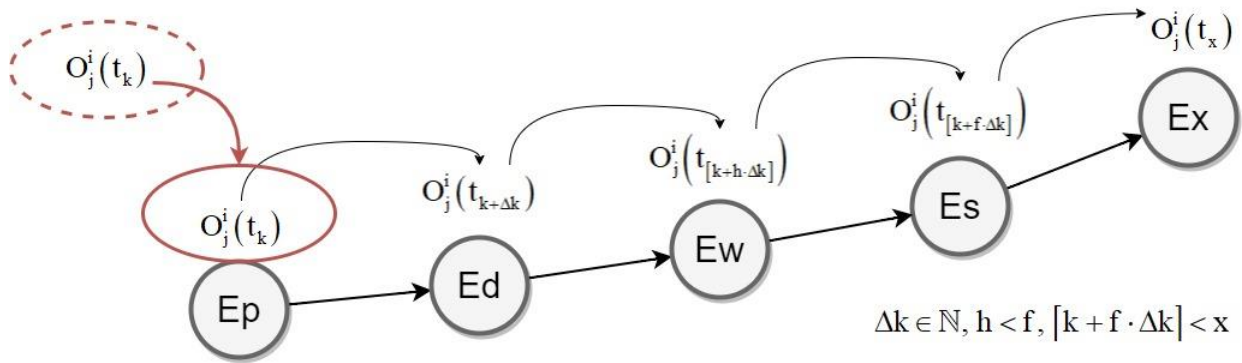


Figure 2.4 - Scheme of adding a new educational project

It should be noted that this scheme can be detailed in more detail, as each of these stages includes a certain number of stages depending on the specifics of the project. However, since each educational project is unique, such a deep detail does not have a tangible effect on the success of the project, but is only a guide for the project manager, who either uses a general traditional detailing scheme or forms his own scheme and adapts existing schemes to the needs of the educational project.

Let's look at the general scheme of detailing the stages above.

Planning an educational project is an important stage that allows you to structure and systematize all stages of the educational project. Below is a general overview of what an educational project plan might look like. However, specific

details may vary depending on the specific requirements and features of the project.

1. Defining the purpose and goals of the educational project. The project goal defines a clear statement of the overall purpose of the project. Project goals should be specific, measurable, achievable, realistic, and time-bound.

2. Audience analysis includes a description of the target audience (age, level of education, interests, and other characteristics), audience needs, i.e. determining how the educational project can meet their needs.

3. Tasks and objectives include breaking down the project into specific tasks and identifying those responsible for their implementation, as well as setting realistic deadlines for the implementation of the educational project, setting time frames for each task.

4. Developing the content of the educational project involves creating specific materials to be used in the project and determining the most effective methods for communicating information.

5. Analysis and planning of educational project resources, including human resources (identifying staffing needs and assigning responsibilities), material resources (assessing the need for finance, equipment, and other material resources)

6. Monitoring and evaluation of the project results includes the formation of a system for monitoring the progress of the project and determining the criteria for assessing success and effectiveness.

7. Communication and stakeholder involvement includes the formation of a sustainable communication plan (determining how interaction with participants and other stakeholders will take place), involvement of groups in the project, stakeholders.

8. Risks and risk management strategies. Developing an action plan to prevent and manage risks and identifying potential problems in educational projects.

9. The timeline of the educational project includes the definition of time frames for each stage of the project and key points to be achieved at different

stages of implementation.

10. Evaluation and analysis includes assessing the impact of the project and evaluating what has been learned and how future educational projects can be improved.

Project development involves completing the tasks under the code points described in the planning. That is, a comprehensive project development must be ensured in accordance with the project goals and the global project matrix.

Implementation of an educational project is a critical stage in which the developed plan is transformed into a real educational program. Here are some key steps to consider when implementing a project.

At this stage, you need to make sure that all the necessary resources (human, material, financial) are available for the project. You need to organize the team and ensure that their tasks and responsibilities are understood. Next, you need to prepare the project infrastructure: make sure that all the necessary premises, hardware, and software are ready for use and provide access to all the necessary resources for project participants. Next, the stage of piloting the educational project for the identified target audience begins. In particular, depending on the project, it may include the start of training on the training module. Next, it is necessary to form mechanisms of interaction and discussion for the participants of the educational project. If necessary, adjustments are made to the plan and methodology based on the data obtained and learning and interaction processes are optimized. It is necessary to ensure transparency and interaction with participants and other stakeholders, to establish links with other organizations or partners that can contribute or support the educational project.

An important step is to evaluate the impact of the project on the target audience and the public and develop a plan for the further development of the educational project. After that, the project is supported on an ongoing basis, its results are evaluated, and adjustments are made if necessary. Those projects that cannot be adjusted are included in the list of completed projects. Evaluations of completed projects are important because they are used to assess the productivity

of the university, to determine the university's ability to implement educational projects of the relevant topic or level.

Thus, at any given time, each university has a specific profile of educational projects, some of which are under development, some are under implementation, and some have already been completed. Understanding the general scheme of the movement of educational projects between life cycle states, it is possible to detail each project separately and consider the model of forming a working group of project implementers and managing the composition of these implementers.

The structure of an educational project plays an important role in managing project human resources. In this paper, we will focus on the following general structure of an educational project, which includes project components or tasks, as well as programmatic outputs or project results. The structure receives descriptions of educational projects as input $\Theta^i = (O_1^i, O_2^i, \dots, O_{n_i}^i)$ for universities $U = (U_1, U_2, \dots, U_m)$.

Educational projects can be educational research or professional training programs. Tasks or components of educational projects can be disciplines taught within these educational programs. Moreover, these components may overlap. Based on the results of mastering the components of educational programs or completing the tasks of educational projects, the results of completing tasks or programmatic results of mastering competencies are formed, as they correspond to the educational components of the programs. Moreover, if the components overlap, then the program outcomes also overlap. The components may not overlap, but the program outcomes may. Or there is a third option, when neither the components nor the program outcomes overlap (Fig. 2.5).

Also, at the entrance to fulfill the tasks of educational projects or implement educational components, a list of potential project executors or research and teaching staff is formed. We denote by

$$R^i = (R_1^i, R_2^i, \dots, R_v^i), \quad i = \overline{1, m} \quad (3)$$

- project implementers for the university U_i , R_k^i - a potential implementer of an educational project, i.e. a research and teaching staff member of the university U_i , $i = \overline{1, m}$, $k = \overline{1, v}$.

We denote by

$$K = (K_1, K_2, \dots, K_H) \quad (4)$$

- is the general list of components or tasks of educational projects, H is the number of components of educational projects.

We denote by

$$K(O_j^i) = (K_1^{O_j^i}, K_2^{O_j^i}, \dots, K_{H_{ij}}^{O_j^i}) \quad (5)$$

- list of components or tasks for an educational project O_j^i university U_i , $j = \overline{1, n_i}$, $i = \overline{1, m}$, H_{ij} - number of components of the educational project O_j^i .

We also denote by

$$P = (P_1, P_2, \dots, P_A) \quad (6)$$

is a general list of results or programmatic outcomes of educational projects, A is the number of components of educational projects.

We denote by

$$P(O_j^i) = (P_1^{O_j^i}, P_2^{O_j^i}, \dots, P_{A_{ij}}^{O_j^i}) \quad (7)$$

list of program results of the educational project O_j^i university U_i , $j = \overline{1, n_i}$, $i = \overline{1, m}$, A_{ij} - number of components of the educational project O_j^i .

Assessment of the mastery of program outcomes can be assessed for an academic group of students, which is determined by a specific target group. If the university U_i presented g^i academic groups

$$G^i = (G_1^i, G_2^i, \dots, G_{g^i}^i), \quad (8)$$

G_b^i - academic group of students or trainees at a university U_i , $b = \overline{1, g^i}$.

Then

$$P(O_j^i, G_b^i) = \left(P_1^{O_j^i, G_b^i}, P_2^{O_j^i, G_b^i}, \dots, P_{A_{ij}}^{O_j^i, G_b^i} \right), \quad (9)$$

where $P_f^{O_j^i, G_b^i}$ - average score of mastering the program result $f = \overline{1, A_{ij}}$ educational project or program O_j^i university U_i academic group G_b^i , $b = \overline{1, g_i}$, $j = \overline{1, n_i}$, $i = \overline{1, m}$.

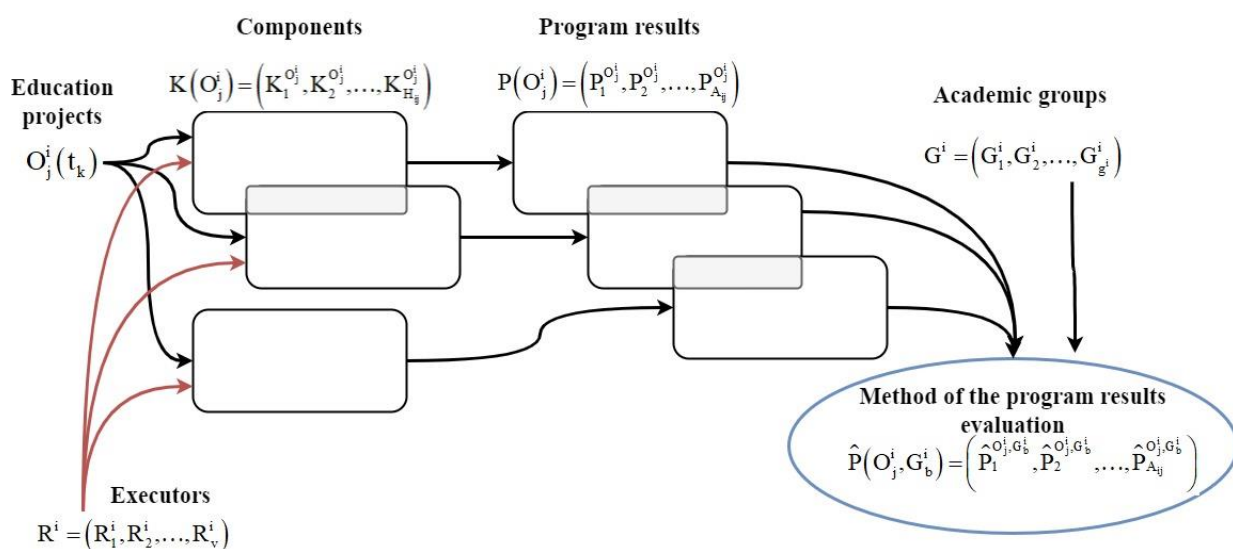


Figure 2.5. - Conceptual scheme of connections between components, performers, results and participants of the educational project

As you can see in Figure 2.5, the performers are distributed among the educational components that form the relevant educational projects. Each component has program results associated with it. They overlap with each other or not. Further, given the method of assessing the learning of program outcomes of a particular academic group, we can talk about a professional assessment of the performer or academic staff member who is responsible for them. This assessment should be independent, transparent and reliable.

The average grade of mastery of the program result is calculated on the basis of the grading scale (Table 2.1) for the relevant group by testing or examining all participants of the group and averaging the results. This indicator is an assessment of the mastery of program outcomes and, accordingly, the assessment of the

academic staff member assigned to the relevant educational component, the result of which is the corresponding program outcome.

Table 2.1.

Scale for assessing the assimilation of program results

Evaluation interval	Interpretation
(90,100]	Excellent assimilation of the program result
(75,89]	Good assimilation of the program result
(60,75]	Satisfactory assimilation of the program result
(50,60]	Mastery of the program result at the level of the passing minimum (depending on the testing system, it may or may not be included in the passing result)
(10,50]	Unsatisfactory assimilation of the program result
(0,10]	Very low result. It is recommended to take the course again.

Accordingly, the relationship between components and performers is defined functionally as follows:

$$F: R_1^i \times R_2^i \times \dots \times R_v^i \rightarrow K_q^{O_j}, \quad (10)$$

$$q = \overline{1, H_{ij}}, \quad j = \overline{1, n_i}, \quad i = \overline{1, m}.$$

The relationship between components and program results is defined functionally as follows:

$$D: K_1^{O_j} \times K_2^{O_j} \times \dots \times K_{H_{ij}}^{O_j} \rightarrow P_f^{O_j}, \quad (11)$$

$$f = \overline{1, A_{ij}}, \quad j = \overline{1, n_i}, \quad i = \overline{1, m}.$$

The complexity of the links between components and program outcomes and the need to involve academic staff in the implementation of relevant educational projects depends on the structure of the educational project. In this study, the scheme shown in Figure 2.5 will be used.

2.2. Model of a working group of educational project implementers

We can hypothesize that the results of an educational project are better the more efficiently the selection of project implementers or academic staff is carried out. To begin with, let's formulate a general model for selecting educational project implementers and forming a working group. To do this, at the first stage, formulate a mathematical model for selecting potential executors of project functions for the project team.

Let $A = \{a_1, \dots, a_n\}$ is a set of applicants who are offered for inclusion in the team of the educational project of the university, $F = \{f_1, \dots, f_m\}$ is a set of functions that must be performed to achieve the goals of the educational project of the university.

Let $K = \{k_{ij}\}_{i=1, \overline{n}}^{j=1, \overline{m}}$ is a matrix of competencies of potential executors of the educational project a_i , $i = \overline{1, n}$, that are able to perform the corresponding function f_j , $j = \overline{1, m}$.

We will also set the integral matrix of values $P = \{p_{ij}\}_{i=1, \overline{n}}^{j=1, \overline{m}}$, which connects the cost of performing the relevant functions f_j , $j = \overline{1, m}$ by each of the potential executors of the educational project a_i , $i = \overline{1, n}$. Let's assume that if $p_{ij} > 0$, the executor a_i performs a function f_j , $i = \overline{1, n}$, $j = \overline{1, m}$. If the performer does not exclude the corresponding function, then $p_{ij} = 0$. We will also set a limit on the number of performers who can perform the function L_j , $j = \overline{1, m}$.

It is necessary to find the composition of the team to perform all the functions of the educational project, taking into account potential performers. Performers can be employees of a particular university or other universities or scientific institutions. The level of detail of the model depends on this.

In the simplest case, the matrix of the composition of the educational project, which will be denoted by $S = \{s_{ij}\}_{i=\overline{1,n}, j=\overline{1,m}}$ is a Boolean, that is, an element of the matrix $s_{ij} \in \{0,1\}$. If $s_{ij} = 0$, then the executor a_i , who was selected for the team of the educational project does not perform the corresponding function f_j . If $s_{ij} = 1$, then the executor a_i , who is selected for the team of the educational project performs the corresponding function f_j , $i = \overline{1,n}$, $j = \overline{1,m}$.

Then we will build the target function for the task of building a project team in the form:

$$\sum_{i=1}^n \sum_{j=1}^m s_{ij} p_{ij} \rightarrow \min, \quad (12)$$

$$\sum_{i=1}^n s_{ij} \geq L_j, \quad \forall j = \overline{1,m}, \quad (13)$$

$$\sum_{j=1}^m s_{ij} k_{ij} = 1, \quad \forall i = \overline{1,n}. \quad (14)$$

This is an optimization task that may arise in the human resources management of the university's educational project. However, the functions of human resources management include many aspects that are related to activity monitoring, motivation systems, change management and dismissal of executors from the project in case of unsatisfactory performance of functions, etc.

In general, such a problem is relatively easy to solve. However, if an educational project has a complex structure with a lot of connections, it will be difficult to find a solution to this problem. In our terminology, if we denote by $R_f^i \subseteq R^i$ - a subset of the set of executors of an educational project for a university U_i , $i = \overline{1,m}$.

Let $P_f^{O_j^i, G_b^i}(R_f)$, $f = \overline{1, A_{ij}}$ - average score of program results related to those components for which implementers belonging to the subset are responsible

$R_f^i \subseteq R^i$. If $K_f^i \subseteq K^i$ - a subset of these components that belongs to the set of all university components U_i , $i = \overline{1, m}$, then we get the problem of maximizing the average value of program outcome assessments:

$$\frac{\sum P_f^{O_j^i, G_b^i}(R_f)}{f} \rightarrow \max, \quad (15)$$

where f - number of program results evaluations.

The peculiarity of forming working groups of educational projects is that the same performer can belong to several educational projects at the same time. Let

$$R(O_j^i) = (R_1^{ij}, R_2^{ij}, \dots, R_{v_{ij}}^{ij}) \quad (16)$$

a set of executors of an educational project or a working group of executors, and

$$R(O_j^i) \cap R(O_k^i) = \emptyset \text{ or } R(O_j^i) \cap R(O_k^i) \neq \emptyset. \quad (17)$$

We will assume that $R(O_j^i) \cap R(O_k^h) = \emptyset$. That is, the project implementer is affiliated with only one university.

2.3. The concept of managing the composition of the working group of an educational project with the formation of a reserve of performers

Human resource management is a complex process aimed at the effective use and development of an organization's main asset - its people. This process covers various aspects of managing people in an organization. In the context of the development of an educational project, human resource management is carried out within a working group.

The working group of an educational project consists of a project manager and project executors, each of whom is responsible for implementing certain project tasks. If we narrow down the understanding of an educational project and consider it as a specific educational program for training specialists in a particular specialty (for example, an educational program for training masters in computer science), then the project tasks will be the educational components (or disciplines)

that provide this educational program and that will allow the program students to obtain the necessary program results. Accordingly, each educational program is assigned a performer (or several performers) or a research and teaching staff member (or several research and teaching staff members) who fully provide teaching (lectures, practical classes, laboratory classes, seminars), final control (exam, test), etc.

In this sense, an educational project has a certain cyclical nature. At the first stage, teachers are selected for each educational component of the program. Next, these teachers develop educational content, teaching materials, form presentations and video lectures, and assignments for practical work, depending on the goals and objectives of the educational project. The last stage involves independent testing of students and evaluation of the results of knowledge acquisition. This assessment determines the teacher's grade.

The elements of human resource management of a project or organization are:

1. Defining tasks and roles. Clearly define the goal and objectives of the educational project. Distribute roles and responsibilities among group members.
2. Selection of qualified participants. Choose participants with relevant skills and experience. Create a diverse team with different competencies.
3. Building team spirit. Promote cooperation and communication within the group. Develop team spirit and mutual support.
4. Ensure effective communication. Establish communication tools and ensure access to necessary information. Ensure regular meetings and interaction through electronic means.
5. Monitoring and evaluation of performance. Identify key performance indicators and establish a monitoring system. Regularly evaluate the implementation of tasks and achievement of goals.
6. Conflict management. Develop conflict resolution strategies. Create an open environment for discussing problems.
7. Skills development and support. Provide opportunities for training and skill development for participants. Provide support and encourage initiative.

8. Adaptation to change. Be prepared for changes in the process and respond quickly to new challenges. Create a flexible structure that allows you to adapt to changes in the project environment.

Managing the composition of the working group is an integral part of the successful implementation of any educational project. Applying these principles will help you create an effective and dynamic team that is ready to meet challenges and achieve goals.

Defining tasks and roles is a critical step in managing an educational project, as it affects the effectiveness and success of the project. At the preparatory stage, before defining roles and tasks, it is necessary to define the goal and objectives of the project. If the goal and objectives are defined, they need to be written down and analyzed in detail. You also need to analyze the project tasks. Consider all aspects of the educational project and identify specific tasks that need to be completed to achieve the goals. Another task is to identify the functions and key activities that correlate with the description of the educational project.

The main methods for defining roles and tasks are:

1. Competency analysis. Assess the skills, knowledge, and experience of each group member. Determine what specific tasks they can perform within the project based on their competencies.

2. Joint discussion. Hold meetings or work sessions where participants can discuss their interests, skills, and expertise. Determine how everyone can maximize their contribution to the educational project.

3. SWOT analysis. Identify the strengths and weaknesses of each group member or academic staff member. Using a SWOT analysis, determine which roles best suit their strengths.

4. Develop responsibility matrices. Create responsibility matrices that clearly indicate the tasks and the participants responsible for completing them. This will help avoid confusion and ensure transparency.

5. Use role-playing games. Use role-playing or simulations to test participants' reactions to different scenarios and determine how each person will

handle specific tasks.

6. Discuss personal goals. Ask participants about their personal goals and ambitions for the project. This can help identify roles that will meet their needs and motivation.

7. Trial phases. Organize trial phases where participants can try out different roles. Assess their productivity and comfort with specific tasks.

The method of competency analysis in the management of human resources in an educational project is aimed at assessing and identifying skills, knowledge, and attributes that may be important for the successful completion of tasks in a particular project. The main feature of this method is to focus on the specific educational needs and requirements of the project. Below are the key stages and features of the competency analysis method in the management of human resources in an educational project:

1. Identification of key competencies. Identification of those competencies that are critical to the successful completion of tasks within a particular educational project. This may include technical skills, soft skills, leadership skills, and other aspects that are important to the performance of tasks.

2. Questionnaires and surveys. Conduct a survey among project participants to collect information about their knowledge, skills, and experience. This may include questions aimed at determining the competencies required to perform specific tasks.

3. Interviews and discussions. Conducting interviews with team members to gain a more detailed understanding of their competencies and individual characteristics. Discussing the contribution and role of each participant in the project.

4. Evaluation of the portfolio and resume. Analyzing resumes, portfolios, and other materials submitted by project participants to determine their level of qualifications and compliance with project requirements.

5. Group exercises and scenarios. The use of group exercises or scenarios where participants can demonstrate their skills and teamwork.

6. Assessment of practical skills. Determining the practical abilities of participants by conducting test tasks or simulations that reflect real project challenges.

7. Comparative analysis. Comparing the data obtained with the project requirements and determining how well each participant meets expectations.

The method of joint discussion in the management of human resources in an educational project involves collecting information and identifying the contribution of each project participant through an open dialogue. The peculiarity of this method lies in the active interaction of participants, taking into account their opinions, experiences and views on critical aspects of human resource management. Below are the critical aspects of this method:

1. Creating an open environment. Providing an atmosphere of openness and mutual understanding where participants can freely share their thoughts, ideas and experiences.

2. Facilitating the discussion. Involve a qualified facilitator who facilitates the development of dialogue and resolves possible conflicts. The facilitator can guide the discussion and encourage participants to participate actively.

3. Asking key questions. Asking specific questions aimed at identifying the interests, skills, and roles of participants in the project.

4. Group work. Use working groups to discuss specific aspects of human resource management together. Group work can bring out diverse perspectives and help participants interact more easily.

5. Stimulating initiative. Support participants' initiative and encourage their active participation in the discussion. This can help identify ideas and solutions that may be important to the project.

6. Analyzing individual considerations. Taking into account the individual views and opinions of each participant. This can reveal the uniqueness of approaches and each person's contribution to project management.

7. Formation of constructive feedback. Facilitate constructive feedback

during the discussion. This can help improve mutual understanding and cooperation in the group.

8. Action planning. Developing specific actions and tasks based on the discussion. This helps to clarify roles and tasks for further implementation.

The participatory discussion method is an important tool for managing human resources in educational projects, as it allows for the involvement of diverse views and experiences of participants, which can lead to more innovative and effective solutions.

When used in the human resource management of educational projects, SWOT analysis allows you to identify strengths and weaknesses in human resource management and identify opportunities and threats to the team. Steps of SWOT analysis in human resource management of educational projects:

1. Strengths. Assessment of qualifications and skills of team members. Identification of qualities that contribute to excellent communication within the group. Identification of individuals with leadership potential and their contribution. Taking into account the previous experience of participants in similar projects.

2. Weaknesses. Identify areas where the team may need additional training. Identification of factors that impede effective communication. Assessment of opportunities to improve skills in new technologies. Identify differences in knowledge and awareness among team members.

3. Opportunities. Identifying opportunities to implement new approaches to learning. Consideration of opportunities to collaborate with other educational institutions to share resources and experiences. Using new technologies to improve team communication. Identify ways to improve the accessibility of educational services for different groups of people.

4. Threats. Analyzing market participants and identifying threats to competition. Assessment of the impact of possible changes in legislation on the educational project. Consideration of possible risks associated with technical problems or vulnerabilities. Consideration of possible funding restrictions and their impact on project implementation.

The method of developing responsibility matrices in managing human resources for an educational project allows you to clearly define each team member's roles and responsibilities. This tool creates a systematic approach to task management and helps to avoid misunderstandings, improve communication, and ensure practical task completion. The main idea is that each participant is assigned specific tasks and clearly understands their role within the project.

Role-playing is an effective tool for managing human resources in educational projects. This method allows participants to empathize with different roles and situations that may arise during the project. The use of role-playing games helps prepare the team for different scenarios and develops cooperation, communication, and decision-making skills.

Recruiting qualified participants in the human resource management of an educational project is a key step in building a successful and effective team. There are several main elements of this method:

1. A thorough analysis of the requirements and needs of the educational project, including technical, professional, soft skills, and other requirements.
2. Develop a clear and attractive job posting or profile description for potential project participants.
3. Placement of the ad on various platforms, including employment sites, social networks, professional communities, and others.
4. Conducting a screening stage to select candidates who meet the basic requirements and criteria.
5. Conducting interviews to assess technical and soft skills, experience, and cooperation.
6. Evaluation of references, i.e. asking for and evaluating feedback from previous employers or colleagues.
7. Assessment center or comprehensive assessment to evaluate candidates, including group exercises, individual tasks and interviews.
8. Assessment of how well a potential participant fits in with the team and project's goals, values, and culture.

9. Involving candidates in test tasks. Use tests that reflect the actual requirements and objectives of the project.

10. Preparing for the onboarding process. Ensuring an effective integration process for new members, including training and familiarization with the team and project.

Monitoring and evaluating human resource productivity is an essential stage of HR management in an educational project. This process helps to determine the team's effectiveness, identify opportunities for improvement, and ensure that project goals are met. The critical aspects of performance monitoring and evaluation include quantitative and qualitative KPIs, i.e., identifying specific parameters by which performance can be measured, such as the number of tasks completed on time, the quality of work performed, the level of participant satisfaction, etc. For effective monitoring, it is necessary to implement performance evaluation systems that allow for different aspects of work, ensure objectivity and regularity of evaluation. In addition, since the functioning of the system can take place in conditions of turbulence of the external environment, which affects the achievement of results, it is necessary to provide for the formation of the so-called reserve of performers, from which the selection of research and teaching staff will be carried out (Fig. 2.6).

Forming a working group of educational project implementers under martial law and a pandemic requires a unique approach and consideration of several factors that may affect the team's ability to work and achieve its goals. Another peculiarity is the use of remote work approaches, the complication of recruitment tasks, etc.

In martial law, the security and confidentiality of information about employees and the safety of employees or executors of an educational project are significant. It is essential to conduct a detailed analysis of potential threats and risks to ensure the safety of participants in the group of students and executors of the educational project.

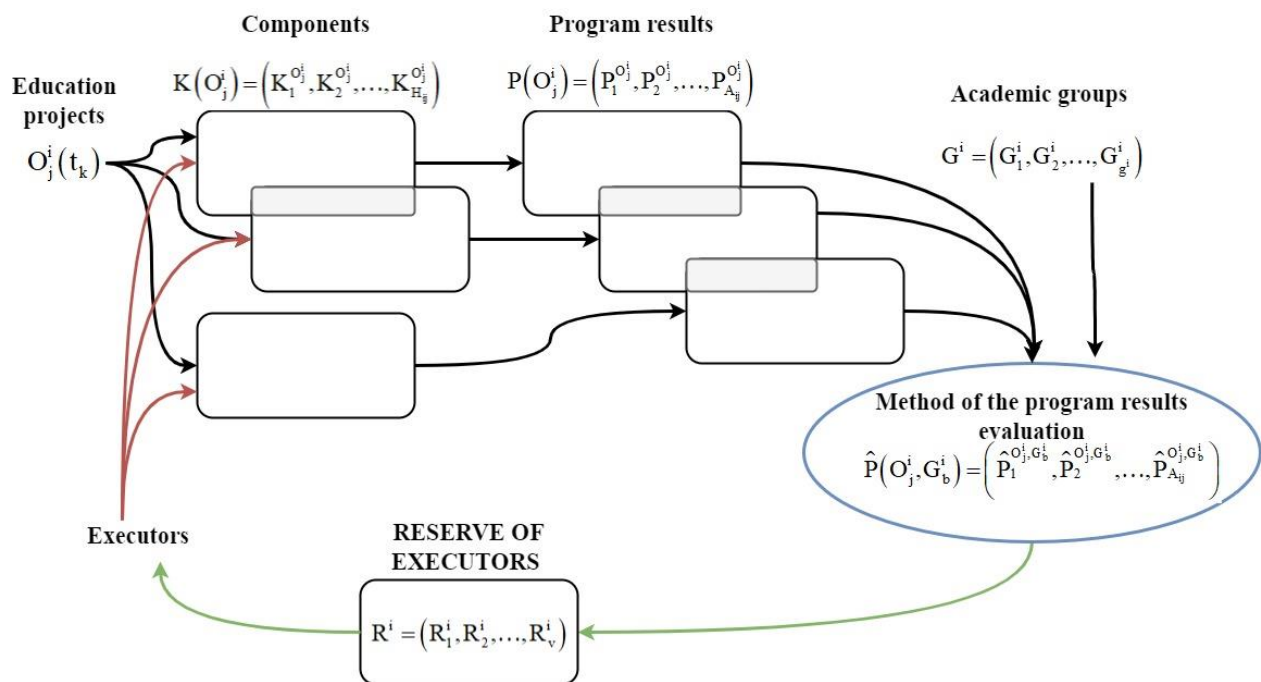


Figure 2.6 - Conceptual diagram of the relationship between components, performers, results and participants of an educational project, taking into account the pool of performers

In case of violation of the requirements, it is necessary to implement the educational project in a remote format. Another critical aspect of working in such conditions is to ensure a high level of confidentiality and protection of the personal data of project participants. Since communication and power supply may be lost, it is important to ensure that working tools and communication infrastructure are available and reliable, even in uncertain conditions. Consideration should be given to using secure information communication tools to ensure stable communication in the event of losing main channels. Under martial law, it is important to create flexible strategies and plans that can be quickly adapted to changes in the situation and to identify mechanisms for preserving and transferring knowledge in the event of losing key participants. Therefore, in the case of this type of turbulence, it is essential to create a reliable, safe pool of potential project implementers who can be involved in the implementation of tasks at any time.

In the case of a pandemic, telecommuting and remote communication are essential aspects of implementing educational projects: the use of virtual platforms, the use and integration of virtual tools for remote work, such as video

conferencing, shared documents, etc., the use of systems to preserve communication history and document sharing to ensure the sustainability of communication.

In these conditions, as in martial law, it is important to resist stress and maintain the emotional well-being of project executors and project participants and their psychological support, which can affect productivity. It is also important to provide flexible work schedules to avoid overload, maintain a work-life balance, and hold virtual events to maintain team spirit and keep participants motivated.

In both cases, regardless of the circumstances, it is important to consider the human factor, consider the participants' individual needs and capabilities, and actively implement tools and approaches to support effective teamwork. The formation of the team in both cases and the management of the working group of executors of university educational projects should be carried out by creating a reserve of potential executors who should be separately evaluated and prioritized for the results of fulfilling the goals and objectives.

The conceptual scheme with the availability of a reserve is possible only in the case of a sufficiently large database on the quality of teachers' work. Since the study plans to create a system for learning and integrate it with a service for students that contains a large amount of data on students, as well as data on courses, teachers of these courses, etc. In addition, since the project began in 2018 and ended in 2023, it is possible to assess how its effectiveness has changed in the face of environmental turbulence, namely the COVID-19 epidemic. The implementation was carried out at a Chinese university, so other turbulences needed to be considered.

Conclusions to chapter 2

1. The paper builds a multiple model of the life cycle of an educational project that defines different stages and phases of the development of an educational project from its inception to completion. The scheme of transition of projects between the stages of the life cycle and improvement

of the educational project is also described. The case when an educational project cannot continue and is completed, the case when a new educational project is created, and the case when an educational project is transformed. That is, formally, the section considers all possible changes that may occur in the life cycle.

2. The general structure of the educational project is formally described, which includes project components or tasks, as well as programmatic outputs or project results. The conceptual scheme of the relationship between the components, performers, results, and participants of the educational project is also described. The feature that distinguishes this organizational structure from the known ones is the emphasis on the educational project, the purpose of which is to train students or students with the ability to assess the quality of work of teachers who are the executors of the educational project as a training program.
3. Formally describes the relationship between educational components and educational project implementers or teachers. The connection between the components and program results is also described. The descriptions were made in order to understand the dependencies of the various components of the educational project.
4. A model for the formation of a working group of educational project implementers has been built, taking into account the peculiarities of the implementation and structure of educational projects carried out for educational purposes at universities, the fact that the performer may belong to several projects at the same time, etc.
5. The concept of managing the composition of the working group of an educational project is described, taking into account the conditions of environmental turbulence due to a pandemic, martial law, etc. This concept envisages the formation of a so-called human resource reserve, which is formed based on the results of teaching by academic staff of other

disciplines. This reserve opens up opportunities to engage educational project implementers or teachers at critical times.

CHAPTER 3. COMPETENCY-BASED METHOD OF HUMAN RESOURCE MANAGEMENT OF EDUCATIONAL PROJECTS

3.1. Competency-based method of managing the composition of the working team of an educational project

For the sake of simplicity, we will assume that we are considering a single project implemented at universities U_i , $i = \overline{1, m}$. For example, a project to train PhD candidates in computer science.

We denote by

$$R^i = (R_1^i, R_2^i, \dots, R_v^i), \quad i = \overline{1, m} \quad (18)$$

- project implementers for the university U_i , R_k^i - executor of an educational project, i.e. a research and teaching staff member of the university U_i , $i = \overline{1, m}$, $k = \overline{1, v}$. Each performer R_k^i will correspond to a tuple of evaluations of the performer's productivity or the quality of his/her teaching of the educational components of the project. The scores are obtained as the average values of the scores based on the results of independent testing of the level of mastery of the program results of the educational components taught by the contractor as a research and teaching staff member. That is, to everyone R_k^i corresponds to a tuple with t_k elements, where t_k – number of educational components taught by the contractor R_k^i , $i = \overline{1, m}$, $k = \overline{1, v}$:

$$\langle K_1^{k,i}, K_2^{k,i}, \dots, K_{t_k}^{k,i} \rangle, \quad (19)$$

$K_j^{k,i} \in [0, 100]$ - numerical evaluation of the performer R_k^i , $j = \overline{1, t_k}$.

These numerical ratings are the performer's competence in teaching the educational components of the program, which is determined by independent testing of course participants. It is clear that this is only one of the components of competence, however, in educational projects aimed at teaching students, the result is the mastery of the relevant program outcomes, so this component was chosen as

the basis for calculating the competence assessment.

An important aspect of ensuring an effective calculation is the organization and funding of independent testing of the code educational component.

If

$$\langle Y_1^i, Y_2^i, \dots, Y_y^i \rangle \quad (20)$$

all educational components taught at the university U_i , then it is possible to build a competence matrix of all performers or teachers of these educational components, consisting of average competence scores:

$$\Delta_i = \begin{pmatrix} K_1^{1,i} & K_2^{1,i} & \dots & K_y^{1,i} \\ K_1^{2,i} & K_2^{2,i} & \dots & K_y^{2,i} \\ \vdots & \vdots & \ddots & \vdots \\ K_1^{v,i} & K_2^{v,i} & \dots & K_y^{v,i} \end{pmatrix}, \quad (21)$$

where $K_j^{k,i}$ - assessment of the performer's competence k from the university i for the educational component j , if $K_j^{k,i} = 0$, the teacher does not teach this educational component.

If

$$\tilde{K}^{k,i} = \frac{1}{t_{k, j, K_j^{k,i} \neq 0}} \sum K_j^{k,i}, \quad (22)$$

where $\tilde{K}^{k,i}$ - the average value of competency assessments for a teacher k .

If $\tilde{K}^{k,i} > H$, the teacher continues to work, if $\tilde{K}^{k,i} < H$, the teacher is being considered for contract termination. If H is close to 100, then the option of rewarding the teacher for excellent performance can be considered (Table 3.1).

In general, a value of $H=60$ can be considered, but depending on the situation, different scales are possible, one of which is shown in Table 3.1.

Table 3.1.

Interpretation of the values of competence assessments $\tilde{K}^{k,i}$

No	$\tilde{K}^{k,i}$	Interpretation
1	(0,35]	Termination or non-renewal of the contract
2	[35,59]	Possible non-renewal of the contract
3	[60,74]	Possible contract extension
4	[75,89]	Contract extension
5	[90,100]	Contract extension, bonuses

The method involves the following steps:

1. Assessment of the qualifications of those university professors who can be involved in teaching.
2. Involvement of teachers in teaching educational components.
3. Formation of groups of students for specific projects.
4. Intermediate and final testing of students to assess the level of mastery of program outcomes that correspond to the project.
5. Averaging test results and comparing them with the competence of teachers. Averaging the values of teacher competency assessments.
6. If the averaged values of competencies exceed the threshold, the teacher continues to work. If the averaged values of competencies are less than the threshold, a decision is made to terminate the contract with the teacher or take other actions. It all depends on the approved protocol by the educational project manager.

3.2. Method of adaptation of resource support for an educational project in the face of environmental turbulence

In a turbulent environment, it is important to create a reserve from the list of performers who can potentially be involved in teaching educational components.

That is, a sequence should be created

$$L^i = (L_1^i, L_2^i, \dots, L_h^i), \quad i = \overline{1, m} \quad (23)$$

- reserve of project executors for the university U_i , L_k^i - executor of an educational project, i.e. a research and teaching staff member of the university U_i , $i = \overline{1, m}$, $k = \overline{1, h}$.

Each performer L_k^i will correspond to a tuple of evaluations of the performer's productivity or the quality of his/her teaching of the educational components of the project. The scores are obtained as the average values of the scores based on the results of independent testing of the level of mastery of the program results of the educational components taught by the performer as a research and teaching staff member.

You can build a competency matrix of backup performers or teachers of educational components, which will consist of average competency scores:

$$\bar{\Delta}_i = \begin{pmatrix} \bar{K}_1^{1,i} & \bar{K}_2^{1,i} & \dots & \bar{K}_y^{1,i} \\ \bar{K}_1^{2,i} & \bar{K}_2^{2,i} & \dots & \bar{K}_y^{2,i} \\ \vdots & \vdots & \ddots & \vdots \\ \bar{K}_1^{h,i} & \bar{K}_2^{h,i} & \dots & \bar{K}_y^{h,i} \end{pmatrix}, \quad (24)$$

where $\bar{K}_j^{k,i}$ - is an assessment of the competence of performer k from university i for educational component j , if $\bar{K}_j^{k,i} = 0$, then the teacher does not teach this educational component.

If

$$\bar{K}^{\equiv k,i} = \frac{1}{t_k} \sum_{j, \bar{K}_j^{k,i} \neq 0} \bar{K}_j^{k,i}, \quad (25)$$

where $\bar{K}^{\equiv k,i}$ - is the average value of competency scores for teacher k from a given pool.

If $\bar{K}^{p,i} < H$ i $\bar{K}^{\equiv d,i} > H$ and the qualification of the teacher d corresponds to the given educational component, then the project manager can replace the teachers, i.e.

$$R^i = (R_1^i, R_2^i, \dots, R_{p-1}^i, R_{p+1}^i, \dots, R_v^i, L_d^i), \quad (26)$$

$$L^i = (L_1^i, L_2^i, \dots, L_{d-1}^i, L_{d+1}^i, \dots, L_h^i). \quad (27)$$

This approach will take place only if the respective teachers belong to the same subject area, i.e. the competence of the teachers L_d^i and R_p^i allow you to teach the same educational components.

The model should also anticipate and take into account possible changes in human resource management in the event of certain environmental turbulence, such as the COVID-19 pandemic and martial law in the country.

The method involves the following steps:

1. Assessment of the qualifications of those university professors who can be involved in teaching.
2. Involvement of teachers in teaching educational components. If a teacher cannot be involved, he or she is placed in the reserve.
3. Formation of groups of students for specific projects.
4. Intermediate and final testing of students to assess the level of mastery of program outcomes that correspond to the project.
5. Averaging test results and comparing them with the competence of teachers. Averaging the values of competency assessments of teachers involved in teaching and reserve teachers.
6. If the averaged values of competencies exceed the threshold, the

teacher is continued to work. If the average competence values are below the threshold, a decision is made to terminate the contract with the teacher and select a teacher from the reserve. The teacher who has the appropriate qualifications and a high competency assessment is selected from the reserve.

Given the diversity of views on the impact of the COVID-19 pandemic on the human resources (HR) industry, it is possible to analyze trends in the HR policies of international companies in 2020-2021. The conditions of systemic adaptation to HR management have led to the use of different approaches in the development of HR strategies by international companies. Let's highlight the main types of HR strategies that have been shaped by the COVID-19 pandemic:

Implementation of the management style of the parent or head company in foreign branches and divisions.

- A strategy to adapt human resource management to local conditions;
- a strategy of a neutral leadership style used in countries with minor cultural differences;
- global strategy of human resources management, which combines different styles of personnel management;
- combined human resource management strategy, which involves the interaction of elements of neutral and global strategies;
- export strategy of human resources management, which includes the transfer of best HR practices that have already been successfully tested in the parent company;
- Integration strategy of human resources management, which involves the transfer of HR best practices regardless of where they were developed.

The development strategy of international companies or educational projects determines how personnel will be managed in these companies or projects. During the pandemic, it has been found that international companies most often use adaptive HR strategies, especially for their foreign branches and divisions. When formulating their own HR strategy, global companies most often implement integrative and/or export approaches (often combining them).

In the context of restrictions related to the pandemic and its consequences, international business structures are focusing on the following approaches to human resource management:

1. Paternalistic (or "motherly") approach:

- The use of HR policies and practices of the parent company is a priority;
- employees from the parent company are appointed to key management positions, especially at the start-up stage;
- key decisions (including personnel decisions) are made in the parent company.

This approach is determined by the fact that the developed HR policies and practices of the parent company are transferred down to the branches, where they become legal standards that are accepted by all units. Representatives of the parent company serve as "guides" of the corporate culture and implement their standards, adapting business processes to local realities.

2. Independent approach:

- Each international business structure in the region is managed locally;
- key positions may be filled by employees recruited from the local labor market;
- HR policies and practices are developed independently, and corporate standards are applied as recommendations rather than binding rules.

Under this approach, each international company in the region is treated as a "state unit". This has its pros and cons. In the case of a limited market (e.g., a lack of qualified professionals), it may be difficult to find candidates for key positions. But showing confidence in local candidates can have a positive impact on the company's image in the eyes of the local community, making it a legitimate player in the market and contributing to the development of the local economy.

3. Global (or geocentric) approach:

- Development and implementation of an integrated HR strategy at the global level;
- creation and development of groups of managers and specialists from

different countries;

- development of universal competencies of employees.

It is undeniable that in the face of pandemic threats, in the era of associations, mergers and integration, more and more international companies are adhering to a geocentric approach to the development and implementation of an HR strategy [123]. Accordingly, it is fashionable to use this strategy for educational projects at universities.

Accordingly, there is a need to develop a rational approach to transformations in the field of human resources management. For example, in today's changing environment, "mobile" staff - "internationals" (or expats) - are specially created to implement large projects in different countries. As part of various international projects and programs, people from different cultures, businesses, countries, etc. are brought together, implementing different corporate standards and policies, and implementing different HR strategies. It should be noted that this approach has positive and negative aspects. Thanks to internationals, the company gains experience in managing foreign projects and builds its own competencies. On the other hand, you have to constantly deal with the adaptation and "cultural integration" of mobile staff. In addition, if there are too many of these specialists, the company loses the trust of local employees. Of course, none of the HR strategies can be found in its purest form; in each particular company, we see a complex interweaving of features characteristic of different approaches.

It is possible to remain a sought-after employee during a pandemic only if the employee is ready to constantly learn, because the transformation of business processes entails new requirements. On the positive side, it is quite easy to improve skills - you don't need to study for years or take out loans to pay for education, you just need to press a few keys and find yourself in a virtual classroom. That is why trend orientation to EVP (Employment Value Proposition) is being implemented.

It is an indisputable fact that in the context of pandemic threats and the era of mergers and integrations, more and more international companies are opting for a geocentric approach to developing and implementing HR strategies [123]. This approach can also be successfully applied to educational projects at universities.

Therefore, it is necessary to develop a rational approach to human resources management, taking into account current trends. For example, "mobile" staff or "internationals" (expats) are actively used to implement large projects in different countries. Within international projects, people from different cultures, business environments, countries, etc. come together to implement different corporate standards and policies that implement different HR strategies. It is important to note that this approach has both positive and negative aspects. With the help of internationals, companies gain experience in managing international projects and develop their own competencies. On the other hand, there are difficulties in the interaction and "cultural integration" of mobile staff. In addition, if there are too many of them, the company may lose the trust of local employees. It is clear that none of the HR strategies is applicable in its pure form; in each particular company, we observe a complex interaction of features inherent in different approaches.

Maintaining high demand in the labor market during the pandemic is only possible if employees are ready to continuously learn, as the transformation of business processes introduces new requirements. On the positive side, improving skills is now easier thanks to virtual learning opportunities that do not require years of study or loans. Thus, current trends are focusing on the Employment Value Proposition (EVP) - an offer for employment.

An EVP is an offer that contains value for an employee from a particular employer and can be compared to a psychological contract. This contract clearly defines the key benefits that the company offers in exchange for the employee's knowledge, efforts and time. Such an offer becomes important because not everyone has the goal of working only for money, and everyone strives for personal development through actions that are meaningful to others.

The famous "4Ps" marketing theory, which includes product, price, place, and promotion, has now received a fifth letter P from HR management - "people". Even if a company has a high-quality product or service, an attractive price, and convenient logistics, a buyer may refuse to make a deal if he or she notices indifference or disinterest in the eyes of employees, or their mechanical performance of duties. This can be avoided if employees understand the importance of their work, feel involved in a useful cause, and feel proud and affiliated with the company.

Another important trend in HR management is the organization of digital workplaces. The impact of the COVID-19 pandemic has led to exceeding all expectations for the future of HR. Process automation, technology, machine learning, and big data analytics have become an integral part of business life, transforming the workplace. Employees can now work efficiently both in the office and remotely thanks to collaboration tools, video conferencing, and various online platforms. This also requires employees to develop technological skills and continuous training. Thus, it is important to focus on innovative approaches in this area when formulating HR strategies in the changing conditions of the pandemic.

Employee behavior in the face of COVID-19 can vary depending on many factors, such as industry, type of work, company's economic stability, and others. Here are some general trends:

1. Layoffs and reduced employment. Many industries, such as hospitality, restaurants, tourism, and others, have seen massive layoffs due to restrictions and lockdowns. Some companies temporarily reduced working hours or offered part-time jobs. The education sector was less affected.

2. Transfers to remote work. Many companies transferred their employees to remote work where possible. This is especially true for information technology, the financial sector, marketing, and other industries where work can be done from home. Accordingly, this trend was most common in the education sector.

3. Holding on to jobs. Some employees, in particular those whose work was recognized as essential, continued to work at their jobs, subject to the necessary safety measures, such as social distancing and the use of protective equipment.

4. Voluntary resignation. Some employees decided to resign due to the unstable economic situation, limitations or ongoing health risks, in particular in the education sector, where contact with people is frequent.

5. Changes in career development. Many people decided to revise their career plans and considered new opportunities or even retraining due to changes in the labor market.

6. Financial instability. Some employees may face financial instability due to job loss or reduced income, which may affect their behavior.

The situation under martial law may cause a variety of reactions among employees, depending on the specific circumstances and individual circumstances. Here are some possible trends in employee behavior under these conditions:

1. Safety and evacuation. Some employees may look for opportunities to evacuate or relocate to safer regions. This is especially true for those living in areas of active hostilities.

2. Layoffs and economic instability. In the context of armed conflict, layoffs and economic instability may occur due to the destruction of infrastructure and restrictions in economic sectors.

3. Selective transfer to another workplace. Some companies may decide to transfer their employees to other regions or countries where the conflict is less active.

4. Working in the context of an escalating conflict. In some cases, especially in industries that require work under martial law (e.g., medicine, humanitarian aid), employees may choose to stay at work despite the risks.

5. Workplace instability. Professional instability may affect employees' decisions to leave or protect their jobs.

6. Economic migration. Some workers may seek employment opportunities in other countries or regions that are not experiencing military conflict.

7. Working on humanitarian projects. Some people may decide to take part in humanitarian projects or join organizations that provide assistance in the context of armed conflict.

Therefore, when planning and managing human resources, it is necessary to take into account possible changes in the turbulent environment, which is partly solved by creating a reserve of performers and assessing their components based on the results of previous work.

3.3. A method for creating clusters of educational projects based on a competency-based approach

Clusters of educational projects are groups or clusters of educational initiatives that unite around a common theme, goal, or direction. This can be an organizational or conceptual structure aimed at improving the educational process, cooperation between educational institutions, supporting innovation in education, and sharing experiences.

Clusters of educational projects facilitate the creation of a common environment for the exchange of knowledge, resources, and best practices among participants. This may include universities, research institutions, companies, NGOs, and other educational or research partners.

This approach helps to optimize the use of resources, stimulate innovation in education, improve the quality of education, and promote the development of educational initiatives. Clusters can occur at different levels, including regional, national, or international educational initiatives.

The method of creating clusters of educational projects based on a competency-based approach is an approach to grouping educational initiatives and projects based on the development of specific competencies of participants or students. The competency-based approach to education aims to develop not only knowledge but also skills, abilities, and personal qualities of the participants in the

educational process. The main stages of the method of creating clusters of educational projects based on a competency-based approach may include:

1. Identification of competencies. Identification of key competencies that are considered important for achieving certain educational goals or objectives.
2. Participant assessment. Analysis of the competencies and skills of participants in educational initiatives.
3. Grouping by competencies. Formation of clusters by combining educational projects aimed at developing similar or interrelated competencies.
4. Creation of clusters. Grouping educational initiatives based on identified competencies to create common project blocks.
5. Program development. Development of curricula and resources aimed at developing specific competencies within each cluster.
6. Cooperation and resource sharing. Facilitating interaction between cluster members to share experiences, resources, and support.

This method promotes the creation of effective educational groups where educational initiatives are focused on specific competencies, which helps participants gain in-depth and practical knowledge to successfully perform tasks in their field.

Read more about the stages of the method. Competency identification is the process of identifying and selecting key skills, knowledge, abilities and personal qualities that are considered important for achieving specific educational goals or objectives. This process helps to determine which specific competencies should be developed by learners or participants in the educational process so that they can function effectively in a particular field or area. Identifying competencies is an important step in the process of developing educational programs and projects, as it allows you to focus on developing those skills and qualities that are of real value to participants and their future success.

Participant assessment, or the analysis of their competencies and skills, is an important step in the development of educational programs and projects. This process helps to understand the current level of knowledge and skills of

participants, identify their needs and weaknesses, and helps to personalize training to better meet the needs of the audience. The assessment of participants not only helps to determine their current skills and knowledge, but also helps to improve the educational process by providing more effective and individualized training.

Competency-based grouping is a strategic approach to organizing educational projects that combines programs and initiatives based on common or interrelated competencies. This approach takes into account not only individual skills or knowledge, but also focuses on the complex competencies that are important for the development of a particular field or industry. Grouping by competencies helps to create a systematic approach to learning, where different projects interact and complement each other, contributing to a deeper understanding and proficiency in a particular field or area.

Creating clusters in educational initiatives is a strategic approach that involves grouping educational projects based on identified competencies to create common blocks of projects or programs. This promotes more systematic and integrated learning, as well as more effective development of participants. The creation of clusters in educational initiatives improves the quality of learning, promotes integration, and ensures more effective development of participants' competencies. This approach allows for a better response to the needs of students and other participants in the educational process within a particular industry or field of activity.

The development of programs in the context of cluster formation in educational initiatives is a key stage, as it determines the learning method, purpose and content aimed at developing specific competencies within each cluster. The creation of programs in clusters of educational initiatives contributes to a more systematic and results-oriented approach to the development of participants' competencies. It also helps to ensure consistency and high quality of education within each cluster.

One of the most important functions is the ability to exchange human resources. In fact, for a certain project that is in a cluster with another project, the

human resources (reserves) of the other project are a reserve for it, and if the projects are not competing with each other, the opportunity to exchange human resources should be taken advantage of. Cooperation and resource sharing in the context of clusters of educational initiatives is an important element, as it promotes interaction between participants, community development, and improving the quality of educational programs. The creation of a cluster is determined by the common goals and interests of the participants. A community of participants that unites around specific competencies or educational goals helps to create a favorable environment for the exchange of experience and resources. Cluster members have the opportunity to share their experiences and best practices with other members of the community. This may include holding seminars, webinars, and workshops where representatives of each project or program can share their successful strategies and challenges.

In addition, resource sharing is provided. Clusters can share a variety of resources, such as training materials, manuals, infrastructure, access to experts, and other resources. This contributes to more efficient use of resources and support for members' projects. Cluster members can support each other in addressing the challenges and problems they face. Working together to resolve difficulties allows for greater efficiency and responsiveness to change.

Cooperation between participants creates opportunities for synergy, when interaction leads to a result that exceeds the sum of individual efforts. Clusters create conditions for creative and innovative work, mutual improvement and growth. Cluster members have the opportunity to expand their network of connections through the exchange of experience and resources. This is important for further development of career opportunities and cooperation in the future. Collaboration and resource sharing establish clusters as effective mechanisms for developing educational initiatives, contributing to the creation of a dynamic and interconnected educational environment.

Conclusions to chapter 3

1. The article describes a competency-based method of managing the composition of the working team of an educational project. This method allows simplifying decision-making by the project manager on human resource management and assesses the competencies of performers as a result of the final testing of students on the quality of mastering the program results of educational components for which performers are responsible.
2. The article describes a method of adapting the resource support of an educational project in the face of environmental turbulence by creating a reserve and assessing the competencies of its participants. This approach helps to reduce the negative impact on the work of projects and the university as a whole in the event of environmental turbulence.
3. To enhance the adaptability of resource provision, the method of creating clusters of educational projects based on a competency-based approach is proposed within this method, which allows solving the problem of providing educational projects with the necessary qualifications and increasing the efficiency of educational project implementation. The peculiarities of creating such clusters and the conceptual vision that another non-competing project in a cluster of a similar direction can be considered as a reserve of human resources are described.

CHAPTER 4. HUMAN RESOURCE MANAGEMENT SYSTEM FOR EDUCATIONAL PROJECTS

4.1. Integration of an international service for students into the human resource management system of an educational project

In order to apply the developed methods of human resource management in real life, considerable work needs to be done to create educational projects as a set of training courses, select the target audience, select teachers in accordance with the competency-based method, and evaluate or monitor teachers, which determines the specifics of managing the composition of the project team. If a teacher fails to cope as a project participant, he or she should be triply excluded from the project.

The first important step to realize the goal of implementing the developed models and methods is to formulate mechanisms for involving students in a set of courses in accordance with the goals of an educational project or program. Therefore, at the initial stage, it was decided to create a service to form the target audience of students. However, the task of creating such software is very extensive and can take years. Another important element of the successful operation of such a service is the search for and involvement of real students, which takes a lot of time. That is why it was decided to integrate a service for students looking for courses for training and professional development into the human resources management system.

In particular, the Chinese International Student Service System (Figure 4.1), an application software for attracting students for study, was used and adapted to the needs of human resources management. The system allows students to find the right university, department, and educational program to study in accordance with their personal preferences, create a curriculum, and assess their ability to complete the course in time for the period of time determined for mastering the required program learning outcomes to master the relevant specialty, in particular in the field of information technology and computer science.

The work was implemented on the basis of Yancheng Polytechnic College. The Chinese International Student Service System was used to select the target audience of students.

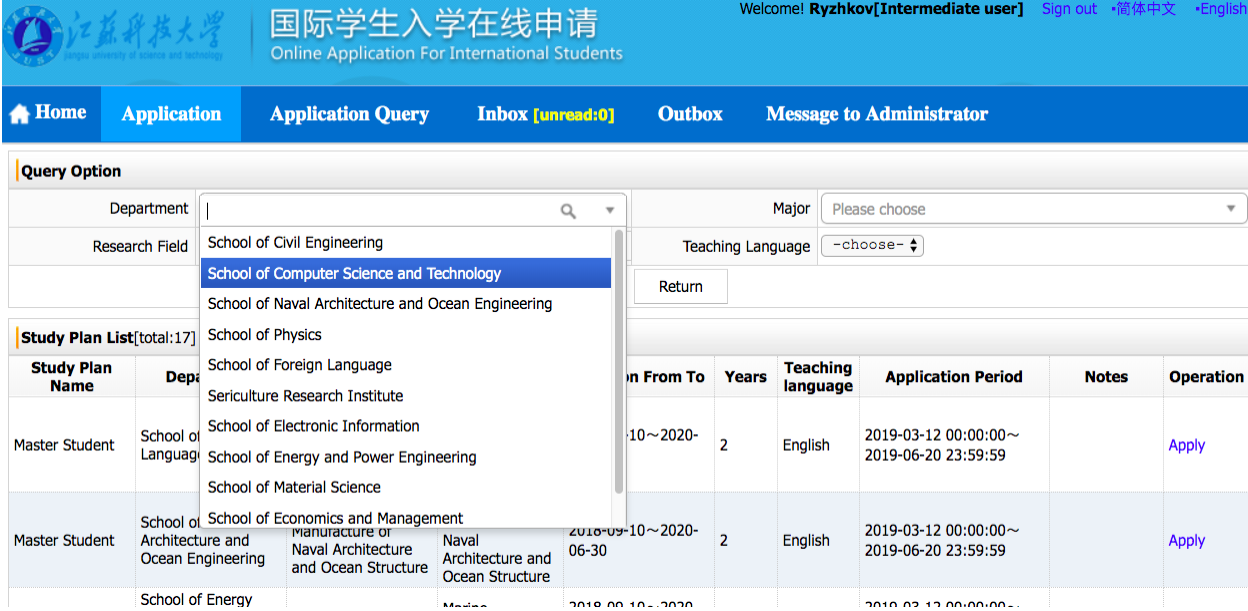


Figure 4.1. - China's international student learning service system

This system is aimed at facilitating the process of enrollment and further education of students as much as possible. Chinese higher education institutions are beginning to integrate the system with internal human resource management services, which is aimed at reducing the time for processing information and facilitating the work of deans' offices. Therefore, the solution used in the study is not new, but without this stage it is impossible to verify the developed methods and models.

The development of the student service system in China is still in the process of transformation. In general, such services allow students to find the necessary courses and universities to study without traveling far from the province in which they live. For example, Fig. 4.2. shows a program that is currently enrolling foreign students in one of the universities in Shandong Province. Figure 4.3 shows a menu where students or trainees can choose the specialty they are interested in studying. Figure 4.4. shows a screenshot of a student's personal profile in the

international student service system, which contains personal information about the student, information about previous studies and interests. The system also provides feedback, i.e. students can talk to the university officials responsible for admissions. A screenshot of the feedback form of the international student service system is shown in Fig. 4.5.



Figure 4.2 - Screenshot of the main menu of the international student service system



Figure 4.3 - Screenshot of the menu for selecting specialties of the international student service system

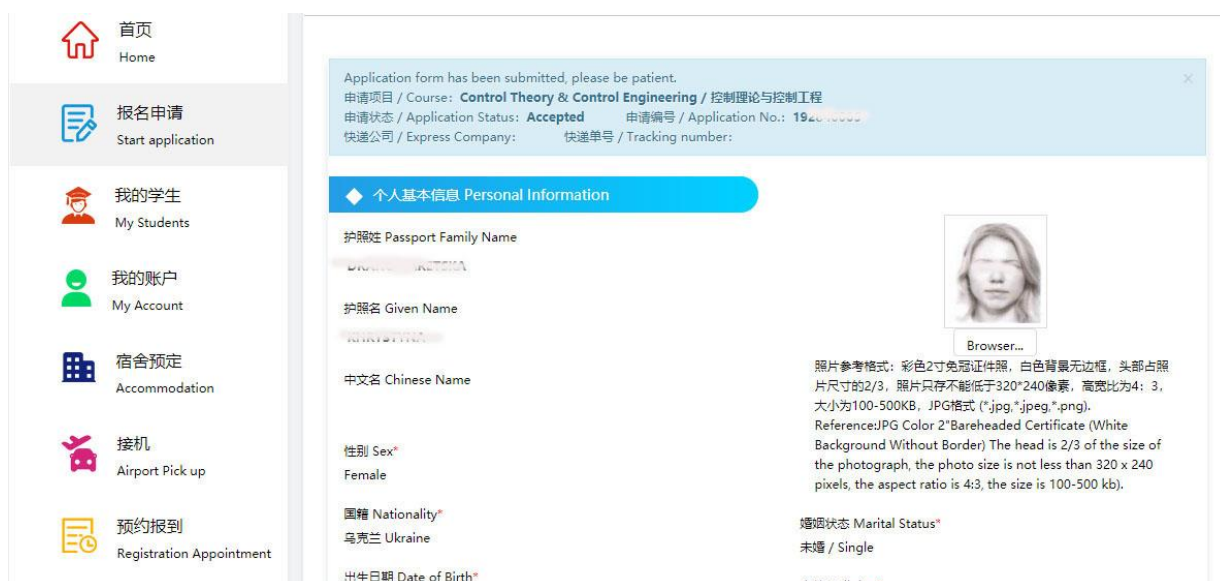


Figure 4.4. Screenshot of a student's personal profile in the international student service system

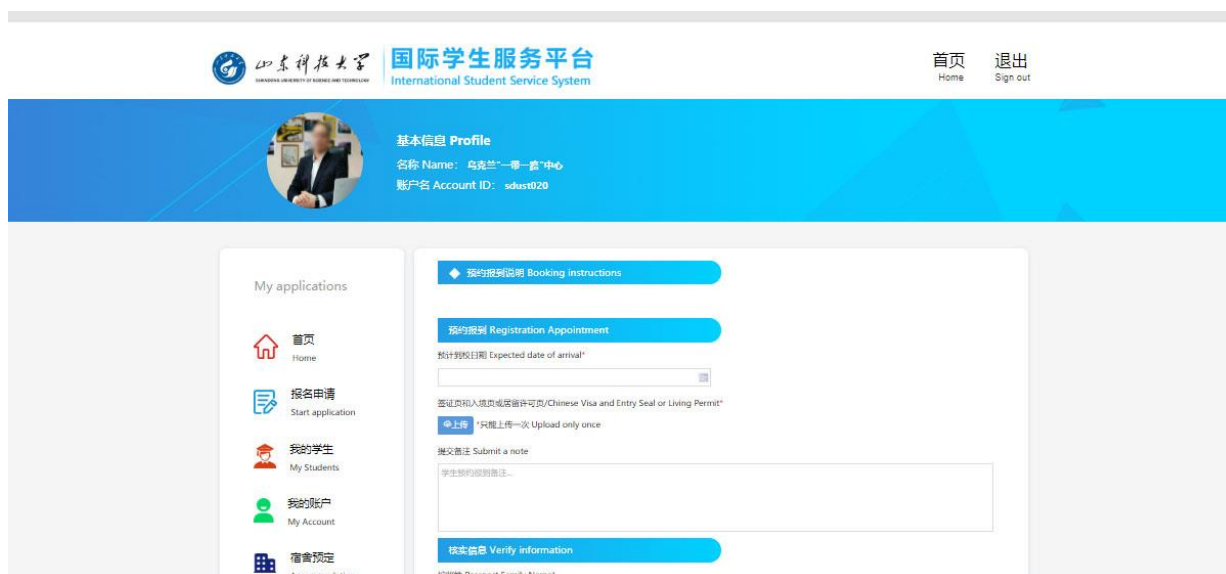


Figure 4.5. Screenshot of the feedback form of the international student service system

Although this system aims to facilitate students' enrollment and further education, its functionality is limited. This system has sporadic integration with higher education institutions' internal human resource management services, but it has yet to reach global development.

Integration of several systems always requires a different set of properties and functions, so there are several approaches to integration, each meeting different needs. However, like any complex technological endeavor, application integration involves a range of considerations and implications that should be considered when choosing an integration approach.

All the applications involved in the integration should minimize their dependence on each other so that each can develop independently without causing problems for the others. Closely related applications make numerous assumptions about how other applications work (usually based on interfaces, contracts). However, integration is broken when applications change and break these assumptions (interfaces, contracts). The interface for integrating applications must be specific enough to implement proper functionality but general enough to allow that implementation to change as needed.

When integrating an application in an enterprise environment, developers must minimize changes to the application and the amount of code required for integration. The solution should be simple. However, changes and new code are usually required to provide good integration functionality, and the approaches with the least impact on the application may not provide the best integration in the enterprise. Integration must also provide flexibility, which is only sometimes provided by simple solutions.

Different integration methods require different amounts of specialized software and hardware. These specialized tools can be expensive and, lead to vendor lock-in and increase the burden on developers who must understand how to use the integration tools. Integrated applications must agree on the data format they exchange or have an intermediate translator to unify applications that use different data formats. Over time, the data format may evolve, change, and expand, affecting the application's functionality. Moreover, the harmonization should occur at the general level (XML, JSON, BLOB) and at the level of data structures transferred between systems. Integration should minimize the time between programs when one sends data and the other receives and can use it. Data should often be

exchanged in small chunks rather than waiting for a large set of unrelated items to be exchanged. Still, the data channel is the bottleneck of any system, so sometimes it is better to reduce the number of requests between integrated systems and send data in one set, increasing the speed of interaction between systems. Integrated applications should be informed when the shared data is ready for consumption. The delay of data exchange should be considered in the integration design; the longer the access takes, the more likely the data is outdated and the more complex the integration becomes [123].

Integrated applications may not exchange data but rather use functions so that each application can use the functionality of other applications. Calling a remote function is complex, and while it may seem the same as calling a local function, it works very differently, which significantly impacts the efficiency of the integration.

To integrate an international student service system with a human resource management system, we used the remote procedure call (RPC) method. In this paradigm, each application has procedures that can be called remotely, and the programs start the data exchange process by such a call. The RPC paradigm has been used to implement many everyday systems. From lower-level applications such as Network File Systems and remote direct memory access to access protocols to the development of the microservices ecosystem. There are several remote procedure call (RPC) approaches: CORBA, COM, .NET Remoting, Java RMI, etc. They differ in the number of supported systems and ease of use. Often, these environments have additional features such as transactions.

File transfer and a shared database allow applications to exchange their data, which is an important part of application integration, but more than simply exchanging data is required. Often, data changes result in having to make changes in different applications. For example, a change of address can be a simple data change, or it can trigger registration and legal processes based on different rules in different legal jurisdictions. Having one application invoke such processes in another would require the applications to know too much about the internal

functions of the other applications. This problem reflects classic problems in application development. One of application development's most powerful structuring mechanisms is the encapsulation mechanism - where modules hide their data through a function call interface. This way, they can intercept changes in the data to perform the various actions they need to do when the data changes. A shared database provides a large, unencapsulated data structure, making data control much more difficult. File transfer allows the application to respond to changes while the file is being processed, but the process is delayed. The fact that a shared database has unencapsulated data also makes it difficult to maintain a family of integrated applications. Many changes in any application can cause changes in the database that significantly impact each application. As a result, systems that share a common database are often very reluctant to change the database, which means that application development work is much less responsive to changing business needs. A mechanism is needed that allows one application to call functions in other applications, pass data that needs to be shared, and call a function that informs the receiving application how to process the data [123].

Remote procedure calling applies the principles of encapsulation to application integration (Figure 4.6). If an application needs some information that belongs to another application, it directly sends a request to the application that owns the information. If one application needs to change the data of another, it sends a request to change the information. Each application maintains the integrity of its own data and can also change data independently of other applications. Today, the leaders in the use of web services are web services that use such standards as: SOAP and XML. A valuable feature is that they easily work with HTTP, which passes through firewalls.

We need to integrate two applications, one of which is a service (an international service for students and a human resource management system). It should be clearly understood that we have two completely independent systems that have a frontend and a backend part that need to interact with each other. The problem of CORS (cross-domain requests) and session cookie storage is solved by

using a reverse proxy, which is configured using the nginx web server. On the server side of the application, the integration is performed using the approach of calling remote procedures via the REST API. The integration scheme is shown in Figure 4.7.

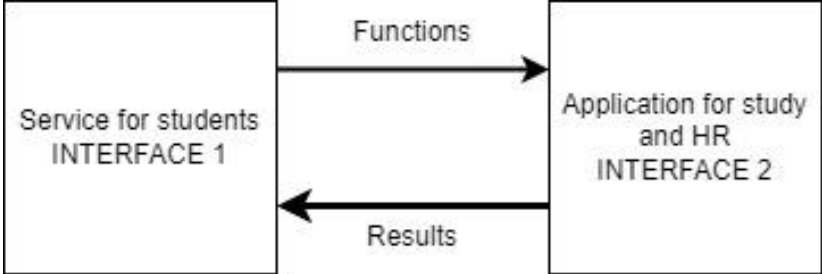


Figure 4.6 - Remote procedure call that applies the principles of encapsulation to the integration of an application for training and human resources management and a service for students

Thus, after recruitment, students from the student service are formed into groups and transferred to the learning platform, which contains a wide range of functions, including a calendar schedule of classes, a curriculum for teaching the discipline. Students can choose the educational components they need to master a specialty. In the course of training, invited lecturers are evaluated and a list is formed with the preferences of lecturers in teaching a particular module.

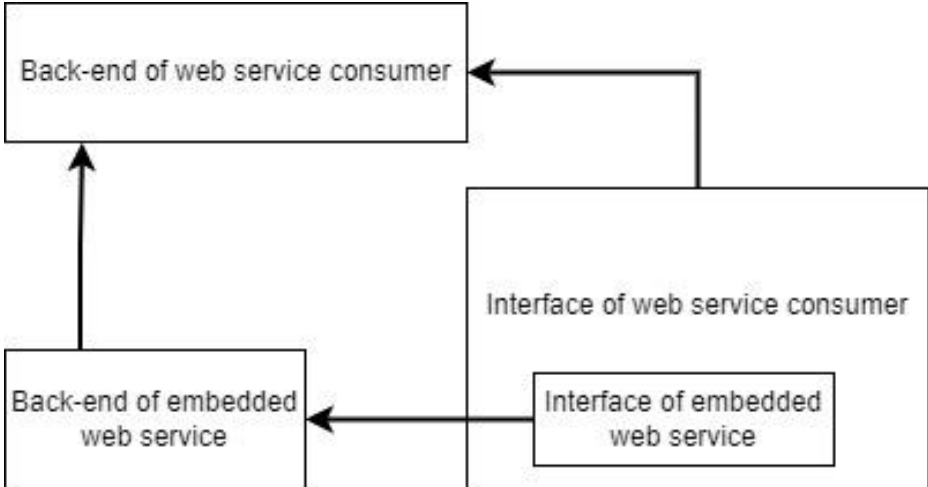


Figure 4.7. - Scheme of integration of the application for training and human resources management and student services

The next section describes in more detail the platform for training and human resource management with which the service for students is integrated. Within this platform, a module for evaluating and selecting teachers who implement the educational project as an educational teaching program has been implemented.

4.2. Creating a learning platform with performance evaluation of IT course teachers

The complexity of integration is also related to the fact that the human resource management system is part of the student learning platform. Students enroll in a specific course through an international service, study, and receive programmed results. In turn, the performance of teachers of the course, which is part of a specific educational project, is implicitly evaluated, and the course is a component of this project (program). This platform is designed to provide both training and evaluation of the quality of teachers' work and to manage human resources of educational projects accordingly.

Figure 4.7 shows a screenshot of the main page of the integrated learning platform with the human resource management function. This functionality is closed to user access and is provided only by the administrator, who can be the manager of the educational project. Figures 4.8, 4.9 show the training calendar for the selected discipline and the curriculum.

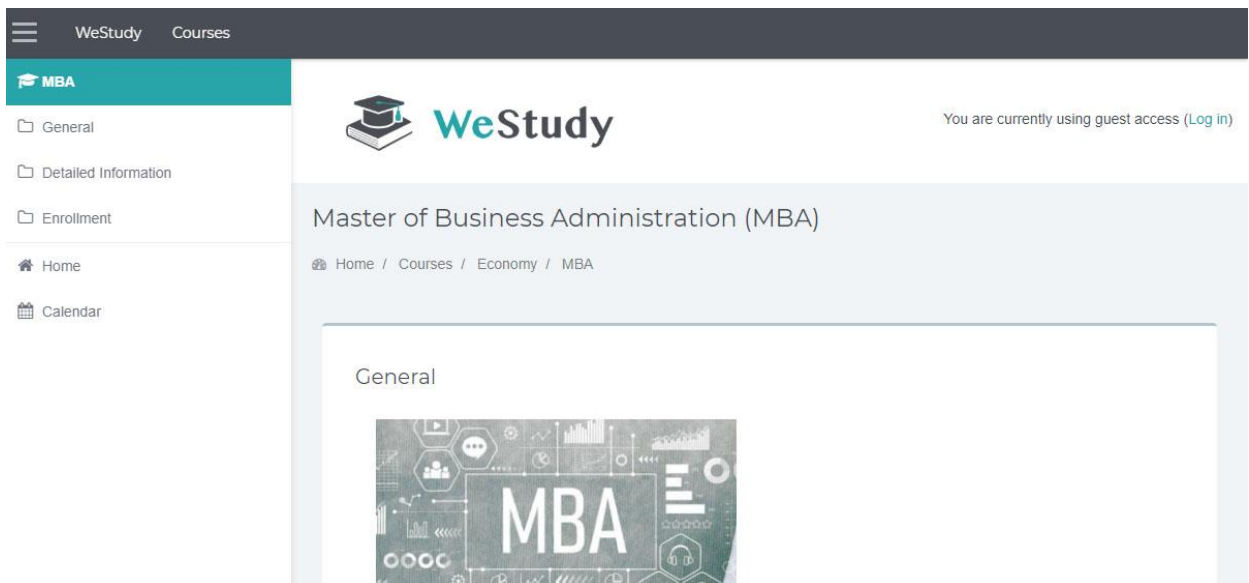


Figure 4.7. - Screenshot of the main page of the integrated learning platform with the human resources management function

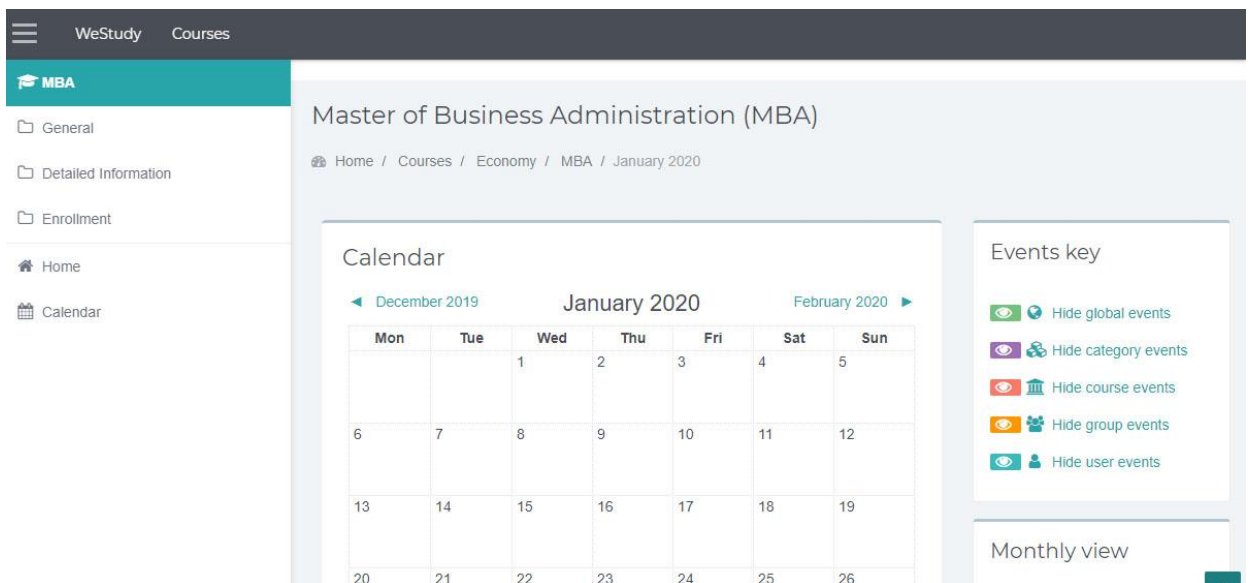


Figure 4.8. Screenshot of the integrated learning platform calendar

The screenshot shows a 'Study Plan' for '1 semester'. It features a table with the following data:

Discipline	Credits	Lections	Self work
Strategic Management	5	75	75
Managerial Psychology	5	75	75
Organizational Behavior	5	75	75
Soft Skills in Human Resource Management	5	75	75
Business Game Human Capital Challenge	5	75	75
HR Strategy and Policy at BU Level	5	75	75

Below the table, the text '2 semester' is visible, indicating the start of the second semester's plan.

Figure 4.9. Screenshot of the curriculum of the integrated learning platform

The Student Learning and Human Resource Management Platform is an innovative tool aimed at improving the learning process and ensuring effective comprehension of the material, as well as for human resource management. Its key features include:

1. E-courses and lectures. The ability to create and study online courses that can be accessed from any device.
2. Interactive tasks and tests. Students can complete tasks and tests to consolidate the material, and the platform automatically evaluates their results.
3. Forums and discussions. The ability to exchange views, ask questions and discuss material with other students and teachers.
4. Online consultations. The ability to conduct virtual consultations to resolve student issues and provide additional assistance.
5. Tools for collaborative learning. Ability to create group assignments and projects for students to work together.
6. Progress monitoring. A system for keeping statistics on student performance, progress and activities on the platform.
7. Adaptive learning. Personalized recommendations and materials according to the individual needs and level of knowledge of students.

A special functionality provided for access only to the platform administrator or its individual participants is the management of the teaching staff or team of educational project executors based on the developed models and methods.

Creating a software platform for student learning with the ability to manage human resources involves many components and technical aspects:

1. User interface (UI). Developing a user-friendly and intuitive interface for students and teachers. Using HTML, CSS, and JavaScript to create a website or web application.

2. Content Delivery. Ensuring the effective display of courses, lectures, assignments, and other educational materials. Using libraries and frameworks such as React or Angular can simplify development.

3. Responsive design. Ensuring the adaptability of the interface for different types of devices (computers, tablets, smartphones).

4. Database management system (DBMS). Use of DBMS, in this case PostgreSQL, to store and manage data, such as information about students, courses, assignments, etc.

5. Programming language. The choice of programming language for backend implementation (in this system Python). This is determined by taking into account the requirements for performance and ease of development.

6. Authentication and authorization. Implementation of secure authentication mechanisms for user login and control of access to various resources on the platform.

7. API (Application Programming Interface). Development of APIs for interaction between the frontend and the backend. GraphQL is used in the implementation of this platform.

8. Features of course management. Mechanisms for creating, editing, and deleting courses, including assignments, lectures, and answers.

9. Analytics and statistics. Collect and analyze data to provide instructors and administrators with information about student progress and course performance, as well as the productivity of instructors responsible for courses.

10. Recommendation system. Development of algorithms for personalized recommendation of materials to students according to their needs and achievements.

11. Features of integration with other services, including email and social networks. Integration with a service for students. Sending notifications and letters to support interaction between students and teachers. Integration with social networks to simplify the registration process and exchange of experience between students.

Let's take a closer look at these items. The development of the user interface for this platform should include a number of points. At the beginning of development, it is necessary to analyze the requirements of users (students and teachers). Understanding their needs and expectations is key to creating an effective interface. After that, you need to create a prototype. Prototyping allows you to visualize the structure and functionality of the interface before you start the active programming process. This can be done with the help of special tools for creating prototypes.

An important element of the implementation is the use of HTML, CSS, and JavaScript. HTML (HyperText Markup Language) is used to create the structure of web pages. CSS (Cascading Style Sheets) is responsible for the look and feel of the pages, while JavaScript allows for interactivity and dynamic elements. It is also important that the learning platform has a responsive design. It is important to develop an interface that is adaptive to different screen sizes (desktop, tablet, mobile). This guarantees an optimal user experience regardless of the device.

The navigation system should be easy to understand and use. Menus should be accessible and intuitive so that users can quickly find the functions and sections they need. If the interface has forms for data entry, it is important to simplify this process and provide users with clear prompts and error messages.

Effective use of graphics and multimedia adds visual interest and can improve the user experience. However, avoid overloading pages with too many elements. Choosing the right color palette and contrast helps to ensure that the interface is

readable and looks good on different devices.

Conducting tests with users allows you to evaluate the effectiveness of the interface, identify possible problems, and get feedback for further improvements. The interface should be constantly improved, especially in accordance with changing user needs and technological trends.

Designing an effective interface is a process that requires consideration of various aspects to ensure usability and satisfaction for all users.

In terms of content, each section of the course should include lectures, assignments, tests, and other learning materials. The effective presentation of these materials contributes to convenient learning. Functionality that allows students and instructors to track their progress, as well as to evaluate and interact on assignments. It should also include images, video, audio, and other multimedia elements to make the information more understandable and engaging, as well as the use of dynamic elements such as test widgets, interactive graphs or elements that enhance the understanding of the material, and the use of popular libraries and frameworks such as React or Angular to develop a dynamic and high-performance interface. A comment system, forums, or other interaction and discussion mechanisms for students and teachers should also be provided. In addition, it should be ensured that the content is effectively displayed on different devices, providing convenient access for desktop, tablet, and mobile users.

When creating a database for the platform, it is necessary to ensure that tables are created for different entities, such as students, courses, assignments, etc. Provide links between tables for efficient data management. Setting up different roles for users (students, teachers, administrators) and configuring access rights to ensure data security. Indexes should also be created for quick access to data and query optimization to improve system performance. Regular backup of the database to protect against possible data loss and to restore information if necessary.

Authentication involves the secure storage of passwords. The use of hash functions to store passwords in the database provides protection against possible

leakage or unauthorized access. Two-factor authentication (2FA) is also possible, i.e., the implementation of 2FA for an additional level of security that requires two methods of identity verification.

It is also necessary to ensure reliable authorization, i.e., setting different levels of access for different categories of users (students, teachers, administrators) depending on their roles and responsibilities. Ensure that administrators can grant, revoke, and change user access rights according to their functional needs.

Additional security tools may include the use of secure token generation and exchange mechanisms to authenticate users and avoid possible attacks. Storage and management of user sessions to ensure security and privacy. Separately, it provides the ability to log user actions and notify of unauthorized actions, use SSL/TLS to encrypt data transmitted between the user and the server, as well as to protect stored data, use RBAC to clearly define roles and related access rights to the platform's functionality, protection against SQL injections, XSS and CSRF.

The collection and storage of information about course participants and other functions are important in a learning platform, including

- collecting basic data about students, including age, gender, previous education, to understand the context of learning;
- tracking student activity in the LMS, such as course attendance, assignments, forums, to determine the level of interest and activity;
- Evaluating and analyzing students' responses to assignments and tests to determine their level of learning. Studying the history of grades and answers to identify trends in student progress;
- using tools to monitor student progress in real time to identify possible difficulties and failures in time;
- creating interactive dashboards and reports for teachers and administrators that show student progress and course performance. Automated notifications to teachers and administrators about important events, such as low academic performance or high activity;
- Introducing a system of discussions and forums to facilitate interaction

between students and instructors, which can also be used to analyze the perception of the material. Ensuring that instructors can receive feedback from students and administrators to further improve their courses;

- studying statistics on the popularity and interest of courses among students to plan further development;

- evaluating course instructors based on student test results;

- using machine learning algorithms to predict student progress and identify possible problems.

Evaluating instructors on a learning platform can be an important part of the process of ensuring the quality of instruction and providing feedback for further improvement. Evaluation can be based on various criteria, and student testing can be one of the key elements of this process. Some aspects of teacher evaluation related to student testing are discussed below:

1. Test results. Teacher evaluation can be based on student performance on tests. It is important to consider not only the overall scores, but also to analyze specific questions and topics where students may have difficulties. Collecting and analyzing statistical data on student responses can help identify course and instructor weaknesses and strengths.

2. Student feedback. Provide opportunities for students to provide anonymous or identifiable feedback about the instructor and the learning process. This can include both general impressions and specific suggestions for improvement. The questions in the questionnaires can relate not only to the course content, but also to the teaching process itself, communication methods, and the availability of the instructor.

3. Use analytics tools to determine the dynamics of student performance at different stages of the course. This can help identify weaknesses and respond in a timely manner. Ensuring that teachers can receive constructive feedback and support the process of continuous improvement.

4. Integration with other sources. Consideration of students' performance in practical tasks and projects that may be part of the course. The use of alternative

assessment methods, including non-testing, other forms of assessment such as portfolios can also be used to obtain a complete picture of the teacher's performance.

These approaches to teacher evaluation allow for a comprehensive system for tracking and improving the quality of learning on the platform.

4.3. Evaluation of the effectiveness of human resource management methods in educational projects

A Chinese higher education institution was chosen to implement the study results. This is because the developments described in this paper will be directly implemented in the education system of the People's Republic of China. The higher education institution chosen was Yancheng Politecnic College. Two departments were involved in implementing the pilot project: the Department of Trade and Finance (dep 1) and the Department of Design and Architecture (dep 2).

The implementation of the concept proposed in this paper began in December 2018. Initially, using an international service for students, offers for studying in 5 educational programs, major disciplines, or educational components taught by teachers of these departments were posted. As a result, 252 students were enrolled in these programs by May 28, 2019. The programs are bachelor's degrees and require 3 years of study: TB1-19 (Trade and business education program), ARD-19 (Architecture and design education program), LD-18 (Landscape design education program), AC-17 (Accounting education program), BAn-17 (Business analytics "new" education program). The number next to the name indicates the year of official program approval.

Each program has a certain number of educational components that provide corresponding program outcomes. From both departments, these educational components are provided by designated teachers whose competencies have been developed and assessed based on the competency-based method. As a result, specialized disciplines from each department are taught by selected teachers, and

general disciplines (physics, biology, humanities, mathematics, etc.) are taught by teachers from other departments not involved in the pilot project. The distribution of the number of teachers, components, and program outcomes is shown in Table 4.2. The total number of teachers in the department dep 1 is 31, and in the department dep 2 - 47.

The training lasted from October 2019 to October 2022, and after each completion of the educational component, a final exam was held in test form and the results were obtained on a 100-point scale.

With the outbreak of COVID-19, the idea arose to optimize the process of finding and appointing human resources to teach disciplines: a pool was organized from which teachers could be selected for distance learning. The reserve was launched in April 2020. By October 2020, it already included 25 people whose competencies were assessed based on a competency-based method, just like other teachers who already worked at the university in these educational programs. Since October 2020, the reserve list has been used. In particular, the share of teachers who did not continue their studies in the main programs and resigned was 4.8%. To fill these positions, teachers were selected from the reserve list. The dynamics of changes in the reserve is shown in Fig. 4.10.

Table 4.1.

Distribution of students by educational programs

№	Educ. program	Num. of students	Number of groups
1	TB1-19	22	1
2	ARD-19	36	2
3	LD-18	17	1
4	AC-17	88	3
5	BAn-17	89	3

Table 4.2.

Distribution of educational components, program outcomes and the number of teachers in the identified educational programs participating in the pilot implementation

№	Educ. program	Num. of ed. components	Number of program results	Number of teachers (dep 1)	Number of teachers (dep 2)
1	TB1-19	30	20	19	1
2	ARD-19	28	17	2	22
3	LD-18	29	15	1	21
4	AC-17	33	18	26	2
5	BAn-17	30	18	22	0

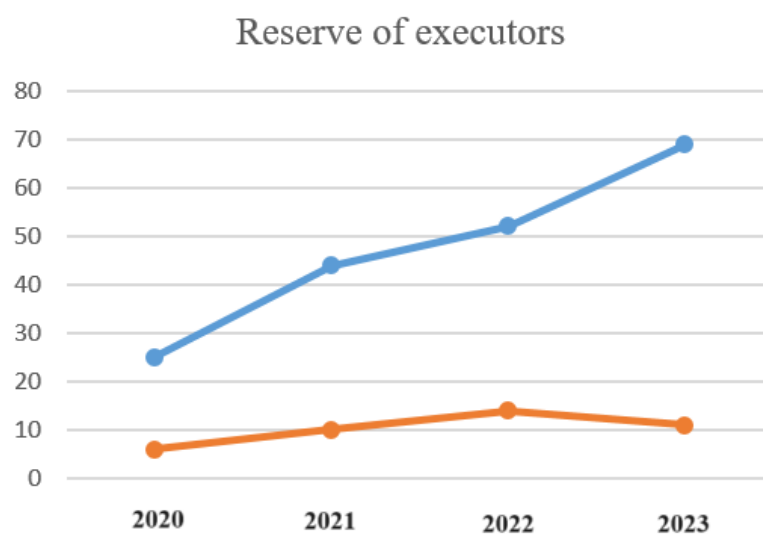


Figure 4.10. - Dynamics of changes in the number of teachers in the reserve. The upper curve is the number of teachers (project implementers), the lower curve is the number of teachers selected from the reserve

Thus, the concept developed in this study was implemented in 2021. The effect of implementation increased in subsequent years as the reserve base increased. In addition, to obtain a meaningful result, it was decided to single out one or two groups in those programs that include more than one group for which

the described methods and models will not be applied. These programs are: ARD-19 (out of two groups, the ARD-19(1) concept is applied to one group, and ARD-19(2) is not applied to the other), AC-17 (out of three groups, the AC-17(1) concept is applied to one group, and AC-17(2) and AC-17(3) are not applied to the other two groups), BAn-17 (of the three groups, the concepts BAn-17(1), BAn-17(2) are applied to two groups, and BAn-17(3) is not applied to the third group), The average results of mastering the program outcomes for each educational program are shown in Tables 4. 3., 4.4., 4.5., in case the concept of reserve is not used. The average results of mastering the program outcomes for each educational program are shown in Tables 4.6., 4.7., 4.8., 4.9., and 4.10. in case the concept of reserve is used. The data are recorded as of July 13, 2023.

Table 4.3.

Average results of mastering program outcomes in the ARC-19 program
(the concept is not used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	1,2	0,8	0,7
2	2	1,1	1,7	1,7
3	3	-0,3	0,1	0,6

Table 4.4.

Average results of mastering program outcomes in the AC-19 program
(the concept is not used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	1,1	1,4	0,9
2	2	1,2	1,5	1,4
3	3	0,2	0,6	-0,1

Table 4.5.

Average results of mastering program results in the program
BAn-17 (the concept is not used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	0,1	-0,3	-0,2
2	2	0,3	0,6	1,6
3	3	0,7	1,4	2,1

Table 4.6.

Average results of mastering program outcomes in the ARC-19 program
(the concept is used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	1,3	1,5	2,1
2	2	1,1	1,9	2,9
3	3	-0,1	0,6	1,9

Table 4.7.

Average results of mastering program outcomes in the AC-19 program
(the concept is used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	1,1	1,5	1,0
2	2	1,2	1,4	1,9
3	3	0,3	0,9	2,4

Table 4.8.

Average results of mastering the program results in the program BAn-17
(the concept is used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	0,2	0,7	1,2
2	2	0,5	0,9	1,8
3	3	0,9	1,8	3,6

Table 4.9.

Average results of mastering the program results in the program TB1-19
(the concept is used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	1,4	1,7	1,9
2	2	1,1	1,4	1,2
3	3	0,9	1,3	1,2

Table 4.10.

Average results of mastering program outcomes in the LD-18 program
(the concept is used)

№	Class	Relative deviation of assimilation of program results by students (%)		
		2019/2020 and 2020/2021	2020/2021 and 2021/2022	2021/2022 and 2022/2023
1	1	0,1	-0,5	0,8
2	2	0,6	1,4	2,0
3	3	0,5	1,5	2,5

Thus, we were able to obtain a positive effect from the implementation of the concept of forming a reserve of performers and their evaluation based on a competency-based method, which made it possible to effectively complete educational projects. The average result without the concept and with the concept implementation for the ARD-19 program is 0.84% and 1.47%, for the AC-17 program - 0.91% and 1.3%, for the BAn-17 program - 0.7% and 1.29%. The average result for the TB1-19 program is 1.34% with the implemented concept, and for the LD-18 program - 0.99% with the implemented concept. That is, all programs are characterized by an increase in the quality of learning program results, which is growing by years from 2019 to 2023. The growth dynamics can be seen in the tables above. The implemented concept of forming a reserve of performers with their assessment by the competency-based method is characterized by an increase of 0.63% for ARD-19, 0.39% for AC-17, and 0.59% for BAn-17. The average growth was 0.54%.

Implementing an HRM system at a university can lead to numerous positive effects, improving various aspects of the institution. Here is a closer look at the positive effects:

1. More efficient personnel management. An HRMS allows you to automate many processes, such as time tracking, employee evaluations, personnel files, etc. This facilitates the tasks of the HR department and allows for more efficient task distribution.

2. Improving the work environment. Tracking working hours and other labor parameters allows you to respond to possible problems in time and avoid overloading employees. This helps to improve the work balance and the overall climate at the university.

3. Optimization of educational processes. HR systems can help to track the work of teachers and administrators, which helps to improve the quality of learning and teaching.

4. Automation of routine tasks. The use of HR systems allows you to automate processes such as vacation registration, time tracking, report generation,

and other administrative tasks, which frees up time for more important tasks.

5. Increase the efficiency of recruitment. HR management systems allow you to collect and analyze candidate data, which facilitates the hiring process and helps you attract highly qualified employees.

6. Improved reporting. HR management systems provide the ability to generate reports and analyze key personnel performance indicators. This helps the administration make informed decisions about development strategies and work processes.

7. Promoting employee development. Monitoring of professional growth and training allows the administration to provide staff with opportunities for development and professional development, which leads to improved quality of educational services.

8. Implementation of standards and policies. HRM systems help to ensure compliance with university standards, policies and procedures, which contributes to the quality of management and compliance.

In the future, it is planned to introduce the described system to other universities in the People's Republic of China.

Conclusions to chapter 4

1. The section describes the principles of integrating the human resource management system with the learning platform and student service, which allows to significantly expand the possibilities for evaluating the executors of educational projects based on the learning outcomes of students of educational components.
2. The scheme of remote procedure calling is described, which applies the principles of encapsulation to the integration of the application for training and human resources management and the service for students.
3. The effectiveness of the application of human resource management methods for educational projects developed in this study was evaluated. A positive effect was obtained from the introduction of the concept of

forming a reserve of performers and their evaluation based on a competency-based method, which made it possible to effectively complete educational projects. All programs are characterized by an increase in the quality of assimilation of program results, which is growing over the years from 2019 to 2023. The implemented concept of forming a reserve of performers with their assessment by a competency-based method is characterized by an increase of 0.63% for ARD-19, 0.39% for AC-17, and 0.59% for BAn-17. The average increase is 0.54%. In the future, it is planned to implement the described concept in other universities of the People's Republic of China.

CONCLUSIONS

In this work, an important task is solved, namely: the development of methods and models of human resources management of educational projects to increase the efficiency of their implementation, taking into account their life cycle, the turbulence of the external environment and the peculiarities of competence-oriented evaluation of their performers, which are inherent in educational projects (scientific component) . It also solves the important task of automating the management of human resources within educational projects, which is based on the development of a management system that integrates with the educational platform and is connected to the service for students (practical component).

The developed methods and models of human resource management of educational projects are the basis of ensuring the effectiveness of their implementation, in particular, improving the quality of teaching and learning of students, students of educational components, and in general, improving the quality of ensuring the educational process, which corresponds to the main goal of the projects. In the short term, the use of theoretical and practical results will provide an opportunity to improve the quality of providing the educational process due to the involvement of the best specialists in teaching the relevant educational components based on a competency-oriented approach, regardless of the impact of external environmental turbulence on this process. In the long term, the use of the developed methods and models will have a positive impact on the development of the quality of education as a whole. The main provisions and results of the research were implemented and applied in the activities of Yancheng Politechnic College.

1. This paper solves an important task, namely, the development of methods and models for managing human resources of educational projects to improve the efficiency of their implementation, taking into account their life cycle, the turbulence of the external environment, and the peculiarities of competency-based assessment of their performers, which are inherent in educational projects

(scientific component). It also solves the important task of automating human resource management within educational projects, based on the development of a management system that integrates into the learning platform and is linked to a service for students (practical component). The study analyzed and found that there are gaps in the development of information technologies for human resource management, in particular e-governance, research is fragmented and practically does not take into account the special conditions of the organization's functioning and external undesirable influences: pandemic, economic crisis, military conflict. At the same time, the private sector's interest in developing this area is growing every year. Thus, the main areas for research relate to the use of information technology for human resource management tasks in general, and their adaptation to special or critical operating conditions is especially relevant.

2. The developed methods and models of human resource management of educational projects are the basis for ensuring the effectiveness of their implementation, in particular, improving the quality of teaching and learning of students, students of educational components, and, in general, improving the quality of the educational process, which corresponds to the main goal of the projects. In the short term, the use of theoretical and practical results will make it possible to improve the quality of the educational process by attracting the best specialists to teach the relevant educational components based on a competency-based approach, regardless of the impact of environmental turbulence on this process. In the long term, the use of the developed methods and models will have a positive impact on the development of the quality of education in general. The main provisions and results of the research were implemented and applied in the activities of Yancheng Politechnic College.

3. The principles and methods of human resource management are presented, and the shortcomings of existing methods are indicated. In the context of the results obtained, it is proposed to improve existing mathematical tools and develop new ones to ensure the effective implementation of educational projects in terms of

human resource management. The current state of development of human resource management systems is analyzed, and a review of well-known systems is carried out. It is established that these well-known tools cannot be effectively used for the task of managing human resources of educational projects due to their specificity: it is difficult to assess the productivity of project implementers (qualitative assessments are available, productivity is influenced by many factors), it is difficult to achieve the goals of an educational project in conditions of change and uncertainty, when the external environment is turbulent (military conflict, pandemic), in the context of educational transformation, competency-based methods must have an adaptive property and adapt to the

4. A multiple model of the life cycle of an educational project has been built, which defines different stages and stages of development of an educational project from its beginning to its completion. The scheme of transition of projects between the stages of the life cycle and improvement of the educational project is also described. The case when an educational project cannot continue and is completed, the case when a new educational project is created, and the case when an educational project is transformed. That is, formally, the section considers all possible changes that may occur in the life cycle. The general structure of the educational project is formally described, which includes project components or tasks, as well as programmatic outputs or project results. The conceptual scheme of connections between components, performers, results, and participants of the educational project is also described. The feature that distinguishes this organizational structure from the known ones is the emphasis on the educational project, the purpose of which is to train students or students with the possibility of assessing the quality of work of teachers who are the executors of the educational project as a training program. The relationship between educational components and educational project implementers or teachers is formally described. The connection between the components and program results is also described. The

descriptions were made in order to understand the dependencies of the various components of the educational project.

5. A model for the formation of a working group of educational project executors has been built, taking into account the peculiarities of the implementation and structure of educational projects carried out for educational purposes at universities, the fact that the executor may belong to several projects at the same time, etc. The concept of managing the composition of the working group of an educational project is described, taking into account the conditions of environmental turbulence due to a pandemic, martial law, etc. This concept envisages the formation of a so-called human resource reserve, which is formed based on the results of teaching by academic staff of other disciplines. The article describes a competency-based method of managing the composition of the working team of an educational project and a method of adapting the resource provision of an educational project in the face of environmental turbulence. Also, to enhance the adaptability of resource provision, the method of creating clusters of educational projects based on a competency-based approach is proposed within this method, which allows solving the problem of providing educational projects with the necessary qualifications and increasing the efficiency of educational project implementation.

6. The principles of integration of the human resource management system with the learning platform and student service are described, which allows to significantly expand the possibilities for evaluating educational project implementers based on the learning outcomes of students of educational components. The scheme of remote procedure calling is described, which applies the principles of encapsulation to the integration of the application for training and human resource management and the service for students. The effectiveness of the application of human resource management methods for educational projects developed in this study was evaluated. A positive effect was obtained from the implementation of the concept of forming a reserve of performers and their

evaluation based on a competency-based method, which made it possible to effectively complete educational projects. All programs are characterized by an increase in the quality of assimilation of program results, which is growing over the years from 2019 to 2023. The implemented concept of forming a reserve of performers with their assessment by a competency-based method is characterized by an increase of 0.63% for ARD-19, 0.39% for AC-17, and 0.59% for BAn-17. The average increase was 0.54%.

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APPENDIX A. ACT OF IMPLEMENTATION



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ACT OF IMPLEMENTATION

The act of implementing the results of the dissertation work of PhD student **Zhou Huan** «**MODELS AND METHODS OF COMPETENCY-BASED HUMAN RESOURCE MANAGEMENT OF EDUCATIONAL PROJECTS**»

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

The results obtained in the work are essential for the project and research activities of our company, as well as scientific cooperation with universities:

1. A multiple model of the life cycle of an educational project was developed, which takes into account the stages of planning, development, implementation, operation and completion of the project and provides opportunities for improving the project if changes are necessary and provides the necessary level of formalization for the further application of methods and models of educational management projects.
2. A competence-oriented method of managing the composition of the working team of an educational project was developed, which considers the peculiarities of the adaptation of the resource provision of the educational project under conditions of turbulence in the external environment.
3. The model of managing the composition of the working group of the educational project has been improved with the formation of a reserve of performers who are evaluated based on the results of the student's completion of the educational components for which these performers are responsible, which in turn allows increasing the effectiveness of the management of the educational project in conditions of turbulence in the external environment.
4. The principles of integration of the human resources management system with the training platform and service for students have been improved, which allows for significant expansion of the possibilities for evaluating the executors of educational projects based on the results of training of students of educational components;
5. The conceptual presentation of the connections between educational components, performers, program results, and participants of the educational project, which is determined by its structure, takes into account the results of the evaluation of performers as a result of knowledge acquisition by students.

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

Yancheng Polytechnic College
Vice-chancellor **WANG SHUDONG**
10 August 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. **Zhou, Huan.** (2019). Development of the System Model for HR-Management in Joint Educational Projects. *Management of Development of Complex Systems*, 37, 127 – 131, dx.doi.org\10.6084/m9.figshare.9783128 [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-37/22.pdf>
2. **Zhou, Huan.** (2019). Trends in the use of IT in human resource management, for example, of higher education institutions in China. *Management of Development of Complex Systems*, 38, 125 – 131, dx.doi.org\10.6084/m9.figshare.9788576. [category «B»] http://urss.knuba.edu.ua/files/zbirnyk-38/21_0.pdf
3. **Zhou, Huan.** (2020). Harmonization of Chinese International Student Service System. *Management of Development of Complex Systems*, 41, 147 – 155, dx.doi.org\10.32347/2412-9933.2020.41.147-155. [category «B»] <http://urss.knuba.edu.ua/files/zbirnyk-41/22.pdf>
4. **Zhou, Huan.** (2023). Information technology for the management of human resources of education projects. *Management of Development of Complex Systems*, 52, 128–132. <https://doi.org/10.32347/2412-9933.2023.55.128-132> [category «B»] <http://mdcs.knuba.edu.ua/article/view/291116>

**Articles in professional publications of Ukraine
(not included in the list of the Ministry of Education and Science of
Ukraine)**

1. **Zhou, Huan.** Trends in the use of it in human resource management on the example of chinese higher education institutions. *Science Journal Innovation Technologies Transfer*. 24-30. 10.36381/iamsti.4.2020.24-30. <http://www.iamsti.org.ua/sjitt-2020-4-09/>

Approbation works

1. **Zhou, H.**, Kolesnikova, K., Morozov, V., Ryzhkov, O. (2021). Human Resource Management in International Educational Service. *Information Technology and Implementation (IT&I-2021)*, 246 – 253. [**Scopus**]

2. **Zhou, H.**, Ryzhkov, O. (2021). HR-harmonization of the Chinese international educational service system. *2021 IEEE Smart Information Systems and Technologies (SIST)*, 1–5, doi: 10.1109/SIST50301.2021.9465909 [**Scopus, Web of Science**]

3. **Zhou, Huan.** (2018). Technologies for HR-management in educational projects. *V international scientific and practical conference "Information technologies and interactions"*, 54-55.

4. **Zhou, Huan.** (2019). System model for HR-management in educational projects. *Conference «Management of projects in the development of society»*, 62-63.

5. **Zhou, Huan.** (2019). HR-management in educational projects. *I international scientific-practical conference, IMTSK-2019 (Information Modeling Technologies, Systems and Complexes)*, 2019, 118.

6. **Zhou, Huan.** (2020). Harmonization of Chinese System for Students.. *Seventh international scientific-practical conference «Management of the development of technologies» Topic: "Information technology development of educational content» Kyiv, 25 – 26 March 2020*, 143-144. [In Ukrainian].