

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

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WANG YINGXING

UDC 004.58+378

PHD THESIS

**DECISION-MAKING SUPPORTS MODELS AND INFORMATION
TECHNOLOGY FOR MONITORING EDUCATIONAL PROJECTS BASED
ON ASSESSING THEIR EXECUTORS COMPETENCIES**

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

_____ Yingxing Wang

Supervisor – **Oleksii Yehorchenkov**, Doctor of Technical Sciences, Docent

KYIV – 2023

SUMMARY

Yingxing Wang. Decision-making support models and information technology for monitoring educational projects based on assessing their executors competencies. – *Qualifying scientific work as a manuscript.*

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

Abstract content. The dissertation is devoted to the construction of mathematical models of decision-making support and information technology for the monitoring of educational projects in dynamics, based on the evaluation of the competencies of the executors of these projects to solve the current scientific and practical task of methods of monitoring and decision-making support for the management of educational projects to achieve the planned work results.

The last few decades have become turning points in the understanding of the importance of the development of education to ensure the sustainability of the development of the economy of the state and entire regions. To intensify the implementation of changes to the quality of the educational process, educational projects are being introduced, particularly with international participation (Jean Monnet, Erasmus+). These projects are designed to share experiences, implement interactive methods in education, ensure inclusiveness, etc. High-quality implementation of such projects requires the involvement of high-level performers, particularly those whose competencies meet the project's requirements. Projects of this type, as a rule, have a complex structure that requires the involvement of specialists from various fields of knowledge, depending on the project's purpose. In addition, it is necessary to understand that performers' competencies change during project implementation and are not static.

For the high-quality implementation of an educational project, in addition to attracting executors with the necessary competencies, it is necessary to create an effective project monitoring system. For this, it is necessary to form a system of measurable indicators that can be collected from open sources that are appropriately verified and have a reliable primary source. It should be noted that the evaluation of

the project is formed by the results of the work of its executors, who have specific competencies that change dynamically. Therefore, the evaluation of the educational project changes over time.

For the effective management of educational projects, information technology must be developed that allows monitoring of the progress of the project and decision-making models, the purpose of which is to ensure the possibility of making changes in the composition of the project team, changing the deadlines for completing tasks, and adjusting the planned results depending on the circumstances.

The idea of creating methods and tools for monitoring educational projects based on assessing the competences of their executors in dynamics is a new vision that will increase the efficiency of project implementation and the level of competencies of their executors. As a rule, it is generally accepted to evaluate projects statically, in particular during and after the completion of project tasks. At the same time, the competence of project executors is not assessed separately, although it is understood that the level of competence of project developers changes after its completion.

This work solves an important task, namely: the development of mathematical methods for monitoring educational projects with a complex structure in dynamics and decision-making models for quality management of educational projects (scientific component), as well as the development of information technology for monitoring educational projects in dynamics, which allows automating the collection processes data and their processing (practical component).

The object of the study is the process of monitoring educational projects and making decisions based on assessments of the competencies of their executors.

The research subject is decision-making models, methods, and means of monitoring educational projects based on assessments of the competencies of their executors.

Research methods. The research is based on knowledge presentation and processing methods, decision-making, monitoring and evaluation methods, and object-oriented programming.

The study aims to develop information technology for monitoring educational projects based on assessments of the competencies of their executors and relevant decision-making models.

The scientific novelty of the obtained results:

- for the first time, a method of forming informational competence environments for executors of educational projects was developed, which is based on quantitative indicators of their productivity and provides the necessary level of formalization for the application of methods and models for assessing the level of competences following the requirements of the educational project;

- newly developed methods of monitoring educational projects based on the dynamics of their informational competence environment, which are based on open data of performers and can be used in the process of planning and managing an educational project at each stage of its implementation;

- improved decision-making support information technology for monitoring educational projects, which differ from the current ones in the comprehensiveness of the approach to monitoring, taking into account the composition and dynamics of the information competence environments of the executors of educational projects;

- further development of decision-making support models for monitoring educational projects based on the dynamics of informational competence environments and models of identification of educational project executors was obtained, which expands the theoretical and practical possibilities of ensuring the effectiveness of the implementation, planning, and management of educational projects.

The first chapter describes the theoretical foundations and analysis of modern competency-based approaches to managing educational projects. This section examines the peculiarities of the formation and implementation of educational projects in universities. Five stages are identified that determine the life cycle of an educational project, including initialization, planning, implementation, monitoring, and completion. For educational projects, an essential addition to these components is the use of the competence method of evaluating the performers of the educational

project in dynamics. The application of competence methods in the implementation of educational projects is described. It was determined that the planning and monitoring of the educational project should be carried out concerning the specifics of the development of competencies as a rational process of improvement and achievement of individual and collective goals of the executors of this project.

It was established that the task of taking into account the dynamics of transformation and development of the competencies of performers and the connection of this development with the tasks of a specific project is unresolved. To ensure effective management and monitoring of the educational project, it is advisable to build information technology to support decision-making based on competency-based methods.

In the second section, the model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, and the model of the interaction of the executors of the educational project team are described. These models differ in that the executor in them is not static, accumulating experience from participation in other projects, giving value to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers. The model of identification of the executor of the educational project is at the basis of the formation of information competence environments.

A method of forming informational competence environments for participants in educational projects has been developed, which differs in the complexity of the approach to assessing the level of competencies, taking into account the level of knowledge, productivity, and personal characteristics of the performers. In addition, due to the continuous transformation of performers, the information competence environment is transformed along with their performers. Determining the mechanism of this transformation is essential for effective monitoring of educational projects.

The third section describes the developed methods of monitoring educational projects based on their information competence environment dynamics. The relationship between the composition of the competence environment of the executors of educational projects and the potential of the projects is described. Models of decision-making support for monitoring educational projects based on the dynamics of information competence environments and models of identification of executors of educational projects are described.

The fourth chapter describes the decision-making support of information technology for monitoring educational projects, which increases the efficiency of educational project management and considers the level of competence of educational project executors. Modules of the decision-making support system for monitoring educational projects of the glass structure are described. Chapter IV defines the goals of building information technology to support decision-making for monitoring competencies and collecting and processing data. Approaches to data analysis and visualization for information technology construction for decision-making support are considered. The developed models and methods are presented, and the process of supporting the developed information technology is described.

The practical significance of the obtained results is that the developed decision-making models and information technology for monitoring educational projects based on the competence approach are the basis for ensuring the effectiveness of educational projects designed to improve the quality of educational process provision. In the short term, using theoretical and practical results will provide an opportunity to improve the quality of implementation of international educational projects, such as Erasmus+, Jean Monnet, etc.. It will also allow for increasing the level of competence of the executors of such projects. In the long term, the use of the developed approaches will positively impact the development of the quality of education as a whole.

The obtained results of both a theoretical and practical nature are the basis for further research aimed at improving and ensuring the sustainability of the development of higher education institutions, which meets the requirements of

international systems for monitoring their activities, taking into account changes in the competences of executors of educational projects that are carried out in these institutions of higher education.

Keywords: educational project, information competence environment, project management, mathematical model, decision support system, project monitoring, performance evaluation of project executors.

LIST OF PUBLICATIONS OF THE APPLICANT BY PHD THESIS TOPIC

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АНОТАЦІЯ

Їнсін Ван. Моделі підтримки прийняття рішень та інформаційна технологія для моніторингу освітніх проєктів на основі оцінки компетентностей їх виконавців. – *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 математичних моделей підтримки прийняття рішень та інформаційної технології для моніторингу освітніх проєктів в динаміці, що базуються на оцінці компетентностей виконавців цих проєктів для вирішення актуального науково-практичного завдання методів моніторингу та підтримки прийняття рішень щодо управління освітніми проєктами з метою досягнення запланованих результатів роботи.

Останні кілька десятиріч стали поворотними в розумінні важливості розвитку освіти для забезпечення сталості розвитку економіки держави і цілих регіонів. Для активізації впровадження змін до якості освітнього процесу запроваджуються освітні проєкти, зокрема з міжнародною участю (Jean Monnet, Erasmus+). Ці проєкти призначені для обміну досвідом, впровадженню інтерактивних методів в навчанні, забезпеченню інклюзивності тощо. Якісне виконання таких проєктів потребує залучення виконавців високого рівня, зокрема тих, чий компетентності відповідають вимогам проєкту. Проєкти такого типу, як правило, мають складну структуру, що потребує залучення спеціалістів з різних галузей знань, залежно від мети проєкту. Крім того потрібно розуміти, що компетентностей виконавців змінюються в процесі виконання проєктів та не є статичними.

Для якісного виконання освітнього проєкту, окрім залучення виконавців з необхідними компетентностями, потрібно створити ефективну систему моніторингу проєкту. Для цього потрібно сформуванню систему вимірних показників, які можуть бути зібрані з відкритих джерел і які є відповідним

чином перевірені та мають надійне першоджерело. Слід зазначити, що оцінку проєкту формує результати роботи його виконавців, які мають певні компетентності, що динамічно змінюються. Відтак, змінюється і оцінка освітнього проєкту з часом.

Для ефективного управління освітніми проєктами мають бути розроблена інформаційна технологія, яка дозволяє моніторити хід виконання проєкту та моделі прийняття рішень, метою створення яких є забезпечення можливості внесення змін в склад команди проєкту, зміна термінів виконання завдань та коригування запланованих результатів залежно від обставин.

Ідея створення методів та засобів для моніторингу освітніх проєктів на основі оцінки компетентностей їх виконавців в динаміці є новим баченням, що дозволить підвищити ефективність виконання проєктів та підвищити рівень компетентностей їх виконавців. Як правило, загальноприйнятою є оцінювання проєктів статично, зокрема в процесі та після виконання завдань проєкту. При цьому компетентності виконавців проєктів окремо не оцінюються, хоча безумовно розуміється, що рівень компетентностей виконавців проєкту змінюється після його завершення.

В даній роботі вирішується важливе завдання, а саме: розроблення математичних методів моніторингу освітніх проєктів складної структури в динаміці та моделей прийняття рішень для якісного управління освітніми проєктами (наукова складова), а також розроблення інформаційної технології моніторингу освітніх проєктів в динаміці, що дозволяє автоматизувати процеси збору даних та їх опрацювання (практична складова).

Об'єктом дослідження є процеси моніторингу освітніх проєктів та прийняття рішень на основі оцінок компетентностей їх виконавців.

Предметом дослідження є моделі прийняття рішень, методи та засоби моніторингу освітніх проєктів на основі оцінок компетентностей їх виконавців.

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

Метою дослідження є розроблення інформаційної технології моніторингу освітніх проєктів на основі оцінок компетентностей їх виконавців та відповідних моделей прийняття рішень.

Наукова новизна отриманих результатів:

- вперше розроблено метод формування інформаційних компетентнісних середовищ виконавців освітніх проєктів, що базується на кількісних показниках їх продуктивності і забезпечує необхідний рівень формалізації для застосування методів та моделей оцінювання рівня компетентностей відповідно до вимог освітнього проєкту;

- вперше розроблені методи моніторингу освітніх проєктів на основі динаміки їх інформаційного компетентнісного середовища, що засновані на відкритих даних виконавців та можуть застосовуватись в процесі планування та управління освітнім проєктом на кожному етапі його реалізації;

- удосконалено інформаційну технологію підтримки прийняття рішень для моніторингу освітніх проєктів, що відрізняються від чинних комплексністю підходу до моніторингу з врахуванням складу та динаміки інформаційних компетентнісних середовищ виконавців освітніх проєктів;

- отримано подальший розвиток моделей підтримки прийняття рішень для моніторингу освітніх проєктів на основі динаміки інформаційних компетентнісних середовищ та моделей ідентифікації виконавців освітніх проєктів, що розширює теоретичні та практичні можливості забезпечення ефективності реалізації, планування та управління освітніми проєктами.

У першому розділі описано теоретичні основи та аналіз сучасних компетентнісних підходів в управлінні освітніми проєктами. В даному розділі розглянуто особливості формування та реалізації освітніх проєктів в університетах. Визначено п'ять етапів, які визначають життєвий цикл освітнього проєкту, що включає ініціалізацію, планування, виконання, моніторинг та завершення проєкту. Вказано, що для освітніх проєктів важливим доповненням до цих складників є використання компетентнісного

методу оцінювання виконавців освітнього проєкту в динаміці. Описано застосування компетентнісних методів в реалізації освітніх проєктів. Визначено, що планування та моніторинг освітнього проєкту має здійснюватись з прив'язкою до особливостей розвитку компетентностей як раціонального процесу вдосконалення та досягнення індивідуальних та колективних цілей виконавців цього проєкту.

Встановлено, що невирішеною є задача врахування динаміки трансформації та розвитку компетентностей виконавців та зв'язок цього розвитку з задачами конкретного проєкту. Для забезпечення ефективного управління та моніторингу освітнього проєкту доцільно побудувати інформаційну технологію підтримки прийняття рішень на основі компетентнісних методів.

В другому розділі описані модель ідентифікації виконавця освітнього проєкту, модель взаємодії виконавця освітнього проєкту з іншим проєктом, модель взаємодії виконавців команди освітнього проєкту. Ці моделі відрізняються тим, що виконавець в них не статичний, він накопичує досвід від участі у інших проєктах, віддаючи в свою чергу цінності іншим проєктам, в яких він бере участь. Тобто в моделях описано неперервний процес вдосконалення та трансформації виконавців освітніх проєктів та вказано який вплив цього вдосконалення на інші проєкти, які ці виконавці виконують. Модель ідентифікації виконавця освітнього проєкту є в основі формування інформаційних компетентнісних середовищ.

Розроблено метод формування інформаційних компетентнісних середовищ учасників освітніх проєктів, що відрізняються комплексністю підходу до оцінювання рівня компетентностей з врахуванням рівня знань, продуктивності та особистих характеристик виконавців. Крім того, завдяки неперервній трансформації виконавців, інформаційне компетентнісне середовище трансформується разом з їх виконавцями. Визначення механізму цієї трансформації важливо для ефективного моніторингу освітніх проєктів.

В третьому розділі описано розроблені методи моніторингу освітніх проєктів на основі динаміки їх інформаційного компетентнісного середовища. Описано зв'язок складу компетентнісного середовища виконавців освітніх проєктів з потенціалом проєктів. Описані моделі підтримки прийняття рішень для моніторингу освітніх проєктів на основі динаміки інформаційних компетентнісних середовищ та моделей ідентифікації виконавців освітніх проєктів.

У четвертому розділі описано інформаційну технологію підтримки прийняття рішень для моніторингу освітніх проєктів, яка дозволяє підвищити ефективність управління освітнім проєктом та враховує рівень компетентностей виконавців освітніх проєктів. Описано модулі системи підтримки прийняття рішень для моніторингу освітніх проєктів складної структури. ВВ розділі описано визначення цілей побудови інформаційної технології підтримки прийняття рішень для моніторингу рівня компетентностей, збір та опрацювання даних. Розглянуті підходи до аналізу та візуалізація даних для побудови інформаційної технології підтримки прийняття рішень. Наведено використання розроблених моделей та методів, а також описано процес підтримки розробленої інформаційної технології.

Практичне значення одержаних результатів полягає у тому, що розроблені моделі прийняття рішень та інформаційна технологія для моніторингу освітніх проєктів на основі компетентнісного підходу є в основі забезпечення ефективності виконання освітніх проєктів, які призначені для підвищення якості забезпечення освітнього процесу. В короткій перспективі використання теоретичних та практичних результатів надасть можливість підвищити якість виконання міжнародних освітніх проєктів, наприклад Erasmus+, Jean Monnet тощо, а також дозволить підвищити рівень компетентностей виконавців таких проєктів. В довготривалій перспективі використання розроблених підходів дасть позитивний вплив на розвиток якості освіти в цілому.

Отримані результати як теоретичного, так і практичного характеру, є підґрунтям для подальших досліджень, спрямованих на удосконалення та забезпечення сталості розвитку закладів вищої освіти, що відповідає вимогам міжнародних систем моніторингу їх діяльності з урахуванням зміни компетентностей виконавців освітніх проєктів, які виконуються в цих закладах вищої освіти.

Ключові слова: освітній проєкт, інформаційне компетентнісне середовище, управління проєктами, математична модель, система підтримки прийняття рішень, моніторинг проєктів, оцінка продуктивності виконавців проєктів.

СПИСОК ПУБЛІКАЦІЙ ЗДОБУВАЧА ЗА ТЕМОЮ ДИСЕРТАЦІЇ

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INTRODUCTION

The last few decades have become turning points in the understanding of the importance of the development of education to ensure the sustainability of the development of the economy of the state and entire regions. Educational projects, in particular with international participation (Jean Monnet, Erasmus+, DAAD), are being introduced to intensify the implementation of changes to the quality of the educational process. These projects are designed to share experiences, implement interactive methods in education, ensure inclusiveness, etc. The impact of projects of this type on the country's education system is significant since each project is aimed at transforming the education system, improving quality, ensuring the standards of the European Union, etc.

High-quality execution of such projects requires the involvement of high-level performers, particularly those whose competencies meet the project's requirements. Projects of this type, as a rule, have a complex structure that requires the involvement of specialists from various fields of knowledge, depending on the project's purpose. In particular, marketers, mathematicians, programmers, teachers, IT specialists, etc. can cooperate in one project. That is, the very structure of the project requires the involvement of performers with different competencies. In addition, it is necessary to understand that the competencies of performers change during the implementation of projects and are not permanent.

The dissertation is devoted to the construction of mathematical models of decision-making support and information technology for monitoring educational projects in dynamics, based on the evaluation of the competencies of the executors of these projects to solve the current scientific and practical task of building methods for monitoring and supporting decision-making regarding the management of educational projects to achieve the planned work results.

For the high-quality implementation of an educational project, in addition to attracting executors with the necessary competencies, it is necessary to create an effective project monitoring system. For this, it is necessary to form a system of measurable indicators that can be collected from open sources that are appropriately

verified and have a reliable primary source. It should be noted that the evaluation of the project is formed by the results of the work of its executors, who have specific competencies that change dynamically. Therefore, the evaluation of the educational project changes over time.

For the effective management of educational projects, information technology must be developed that allows monitoring of the progress of the project and decision-making models, the purpose of which is to ensure the possibility of making changes to the composition of the project team, changing the deadlines for completing tasks, and adjusting the planned results depending on the circumstances.

Improvement of educational project monitoring systems and the construction of competence environments are part of the studies of Bushuyev S.D., Bykov V.Yu., Biloshchytskyi A.O. However, these studies looked at project executors statically. This study implements the idea of creating methods and tools for monitoring educational projects based on assessing the competencies of their executors in dynamics, which is a new vision that will increase the efficiency of project implementation and the level of competencies of their executors. As a rule, it is generally accepted to evaluate projects statically, in particular during and after the completion of project tasks. At the same time, the competence of project executors is not assessed separately, although it is understood that the level of competence of project developers changes after its completion.

This work solves an important task, namely: the development of mathematical methods for monitoring educational projects with a complex structure in dynamics and decision-making models for quality management of educational projects (scientific component), as well as the development of information technology for monitoring educational projects in dynamics, which allows automating the collection processes data and their processing (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 the study is the process of monitoring educational projects and making decisions based on assessments of the competencies of their executors.

The research subject is decision-making models, methods, and means of monitoring educational projects based on assessments of the competencies of their executors.

Research methods. The research is based on knowledge presentation and processing methods, decision-making, monitoring and evaluation methods, and object-oriented programming.

The study aims to develop information technology for monitoring educational projects based on assessments of the competencies of their executors and relevant decision-making models.

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

1. To analyze competence approaches used for managing and monitoring educational projects. Consider in detail the stages of the functioning of the educational project to understand the place of models and methods, as planned to be developed, in the canvas of international educational projects with different structures. Consider project evaluation in static and dynamic dimensions.

2. To use competency-based methods for monitoring educational projects, it is necessary to understand the executor of an educational project in detail. That is, it is necessary to build a model of the identification of the executor of the educational project, a model of the interaction of the executor of the educational project with another project, a model of the interaction of the executors of the educational project team. Moreover, these models should consider the variability of the level of competencies of the executors of educational projects. From the model of identification of the executor of the educational project, it is necessary to move to the construction of informational competence environments of the participants of educational projects. An appropriate method should be described, which should differ in the complexity of the approach to assessing the level of competencies, taking into

account the level of knowledge, productivity and personal characteristics of the performers.

3. The next stage should be the development of methods for monitoring educational projects, considering the dynamics of their informational competence environments. Another essential task is to establish the connection between the composition of the competence environment of the executors of educational projects and the potential of the projects. For this, it is necessary to determine the method of calculating the potential of the educational project.

4. At the next stage, it is necessary to describe decision-making support models for monitoring educational projects based on the dynamics of informational competence environments and models for identifying executors of educational projects. Decision-making should take place by the project manager in the context of changes in the composition of project executors, i.e. adjustment of the information competence environment and other change management tasks.

5. According to the results of the creation of mathematical and theoretical construction, to automate the process of project monitoring based on the competence principle, it is necessary to develop and describe the decision-making support information technology for the monitoring of educational projects, which allows to increase the efficiency of educational project management and takes into account the level of competencies of the executors of educational projects. Modules for data collection, visualization, and decision-making should be described accordingly. The process of supporting the developed technology, etc. is described in detail.

The scientific novelty of the obtained results:

- for the first time, a method of forming informational competence environments for executors of educational projects was developed, which is based on quantitative indicators of their productivity and provides the necessary level of formalization for the application of methods and models for assessing the level of competences following the requirements of the educational project;

- newly developed methods of monitoring educational projects based on the dynamics of their informational competence environment, which are based on open

data of performers and can be used in the process of planning and managing an educational project at each stage of its implementation;

- improved decision-making support information technology for monitoring educational projects, which differ from the current ones in the comprehensiveness of the approach to monitoring, taking into account the composition and dynamics of the information competence environments of the executors of educational projects;

- further development of decision-making support models for monitoring educational projects based on the dynamics of informational competence environments and models of identification of educational project executors was obtained, which expands the theoretical and practical possibilities of ensuring the effectiveness of the implementation, planning and management of educational projects.

To solve the problems of the dissertation research, the first chapter of the work describes the theoretical foundations and analysis of modern competency-based approaches to managing educational projects. This section examines the peculiarities of the formation and implementation of educational projects in universities. Five stages are identified that determine the life cycle of an educational project, including initialization, planning, implementation, monitoring and completion. It is indicated that for educational projects, an essential addition to these components is the use of the competence method of evaluating the performers of the educational project in dynamics. The application of competence methods in the implementation of educational projects is described. It was determined that the planning and monitoring of the educational project should be carried out concerning the specifics of the development of competencies as a rational process of improvement and achievement of individual and collective goals of the executors of this project.

It was established that the task of taking into account the dynamics of transformation and development of the competencies of performers and the connection of this development with the tasks of a specific project is unresolved. To ensure effective management and monitoring of the educational project, it is

advisable to build information technology to support decision-making based on competency-based methods.

In the second section, the model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, and the model of the interaction of the executors of the educational project team are described. These models differ in that the executor in them is not static, he accumulates experience from participation in other projects, giving in turn, values to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers. The model of identification of the executor of the educational project is at the basis of the formation of information competence environments.

A method of forming informational competence environments for participants in educational projects has been developed, which differs in the complexity of the approach to assessing the level of competencies, taking into account the level of knowledge, productivity and personal characteristics of the performers. In addition, due to the continuous transformation of performers, the information competence environment is transformed along with their performers. Determining the mechanism of this transformation is essential for effective monitoring

The practical significance of the obtained results is that the developed decision-making models and information technology for monitoring educational projects based on the competence approach are the basis for ensuring the effectiveness of educational projects designed to improve the quality of educational process provision. In the short term, using theoretical and practical results will provide an opportunity to improve the quality of implementation of international educational projects, such as Erasmus+, Jean Monnet, etc.. It will also allow to increase the level of competence of the executors of such projects. In the long term, the use of the developed approaches will positively impact the development of the quality of education as a whole.

The practical value is that as a result of the work:

1. Methods of monitoring educational projects are analyzed and proposed, considering their complex structure and the dynamics of the information competence environment.

2. Information technology was developed and implemented to support decision-making regarding the management of educational projects based on a competency-based approach to the composition of their executors. Mathematical and software individual modules of the system for monitoring international educational projects have been developed.

The obtained results of both a theoretical and practical nature are the basis for further research aimed at improving and ensuring the sustainability of the development of higher education institutions, which meets the requirements of international systems for monitoring their activities, taking into account changes in the competences of executors of educational projects that are carried out in these institutions of higher education.

The main provisions and results of the research were implemented and applied in the activities of Zhejiang ACME Information Technology Co. LTD.

Personal contribution of the acquirer. The applicant personally received the main provisions and results of the dissertation work. In work [1], the principles of transformation of the competencies of the executors of educational projects are described. The work [2] describes the principles of developing information systems for decision-making support and information technologies for educational projects. In the work [3], published as a co-author, the author describes the methods of monitoring educational projects based on their information competence environment dynamics. In work [4], a method of forming information competence environments of educational project executors and a model of identification of educational project executors was developed. Work [5] describes the criteria for ensuring professional competencies in the example of Chinese educational institutions. –The materials from international conferences were also published, in which the provisions of the dissertation work are revealed in more detail [6-10].

Approbation of the results of the dissertation. The main results of the work were reported, discussed, and received a positive evaluation at IEEE conference "Smart Information Systems and Technologies" (SIST-2021), Astana, Republic of Kazakhstan, as well as at 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) .

Publications. Based on the dissertation materials, 10 scientific works have been published, including: 4 scientific articles in specialized publications of Ukraine, one of them in a publication that is indexed by the Scopus database, 1 article in a publication that is not included in the list of the Ministry of Education and Culture, 5 materials of international conferences. The main results of the work were obtained by the author personally. Of the scientific works published in co-authorship, the dissertation research describes those provisions resulting from the author's personal work.

Structure and scope of work. The dissertation consists of an introduction, four chapters, chapter conclusions, main conclusions, a list of references and appendices. The total volume of the dissertation is 156 pages, of which the central part is 122 pages, including 22 figures, 8 tables, a bibliography of 114 titles and 2 appendices.

CHAPTER 1. THEORETICAL BASICS AND ANALYSIS OF MODERN COMPETENCE APPROACHES IN EDUCATIONAL PROJECT MANAGEMENT

1.1. The concept of educational projects as collective processes of ensuring learning goal

Depending on the task, educational projects can provide information and education for interested groups [11, 12]. An educational project is also called a document of an educational nature, which is prepared by the educational community to determine the features that a specific center identifies, formulates the goals it wants to achieve and expresses its functional and organizational structure [13]. An educational project is a process of planning, developing and implementing initiatives to improve the educational process and ensure quality education as a whole. The educational project can be implemented for different target groups: from individual students and teachers to universities and even individual regions or the country.

In this study, we will understand the educational project as a collective process of cooperation, which often has a complex structure, involving teachers, teachers, technical specialists and other workers to ensure the planned learning outcomes. This process is subject to the document, which describes the goals and program results of the project, the stages of achieving these results, etc. We will also assume that this process forms a sequence of actions coordinated by the project goal. The goal of educational projects is mainly defined as increasing the level of knowledge and acquiring competencies of the students of the developed course or module on a specific topic.

To achieve goals, several tasks are often formulated:

- creation of an educational module or several educational modules on a specific topic, as well as independent evaluation of these modules;

- support and dissemination of information about the developed modules, as well as the involvement of students in passing the modules with appropriate certification after their completion;

- writing of scientific articles by project participants and reports at conferences with an overview of the results of training of control groups of trainees and their testing;

- if, as a result of the training of the control group of students, an apparent positive effect of the implementation of the modules is ensured, then other groups are formed for training.

So, the educational project provides goals related to the training, retraining, or improvement of the qualifications of some target groups. Also, elements of training can be implemented during the implementation of the project, but the results can have goals that are a consequence of the training of the target groups.

The project's development involves using a systematic, interactive process of evaluation, design and implementation of results. In general, this process is non-linear. Each stage of project development can be described, but the stages overlap, and the terms of their execution can be flexibly changed. This helps to ensure the quality of project tasks. The development of an educational project is, as a rule, cyclical. The results of completing one stage are input data for starting the project's next stage. The place of strategies, projects, programs and activities in the university's activities is shown in Figure 1.1. The development strategies of the university are related to the initiation and development of programs within which projects, particularly educational projects, are organized. Each program project is associated with specific activities designed to effectively achieve the project's results. Activities are also part of separate programs. Educational projects, programs and activities strictly correspond to the purpose and strategy of the university.

In figure 1.2. the components of the project development cycle are described. These components help to form and plan a high-quality educational project, the assessment of which will be high.

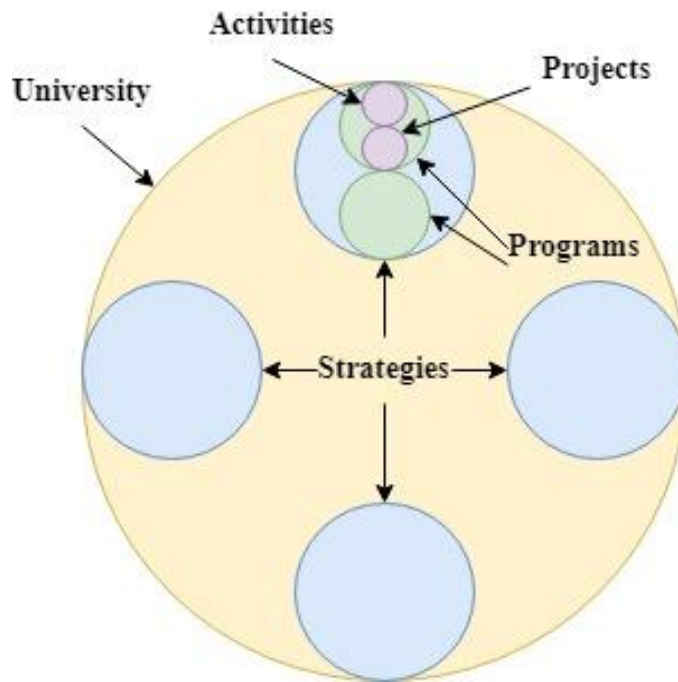


Figure 1.1. - The place of strategies, projects, programs and activities in the structure of the university's activities

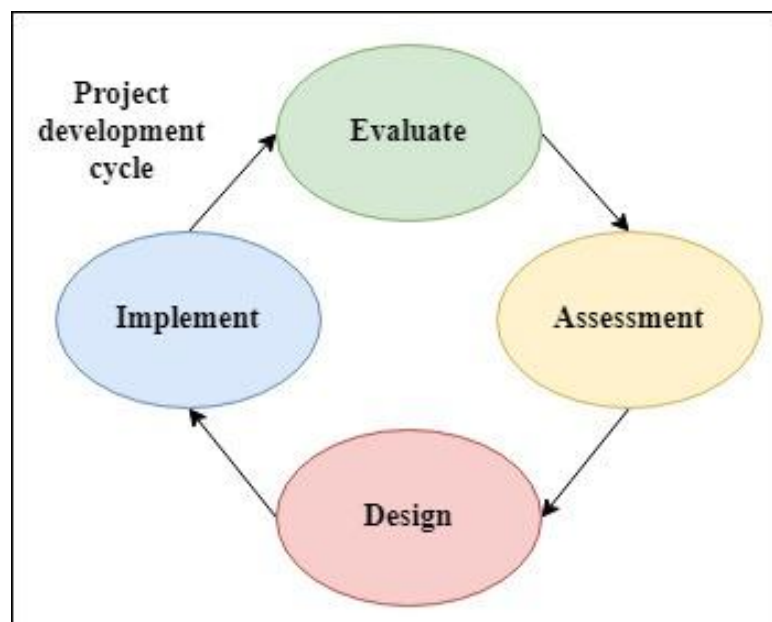


Figure 1.2. – Cycle of development of educational projects

The main model, which is the basis of creating and obtaining the results of educational projects, is the TOP model (model of targeting program results), which is described in work [14] (Fig. 1.3).

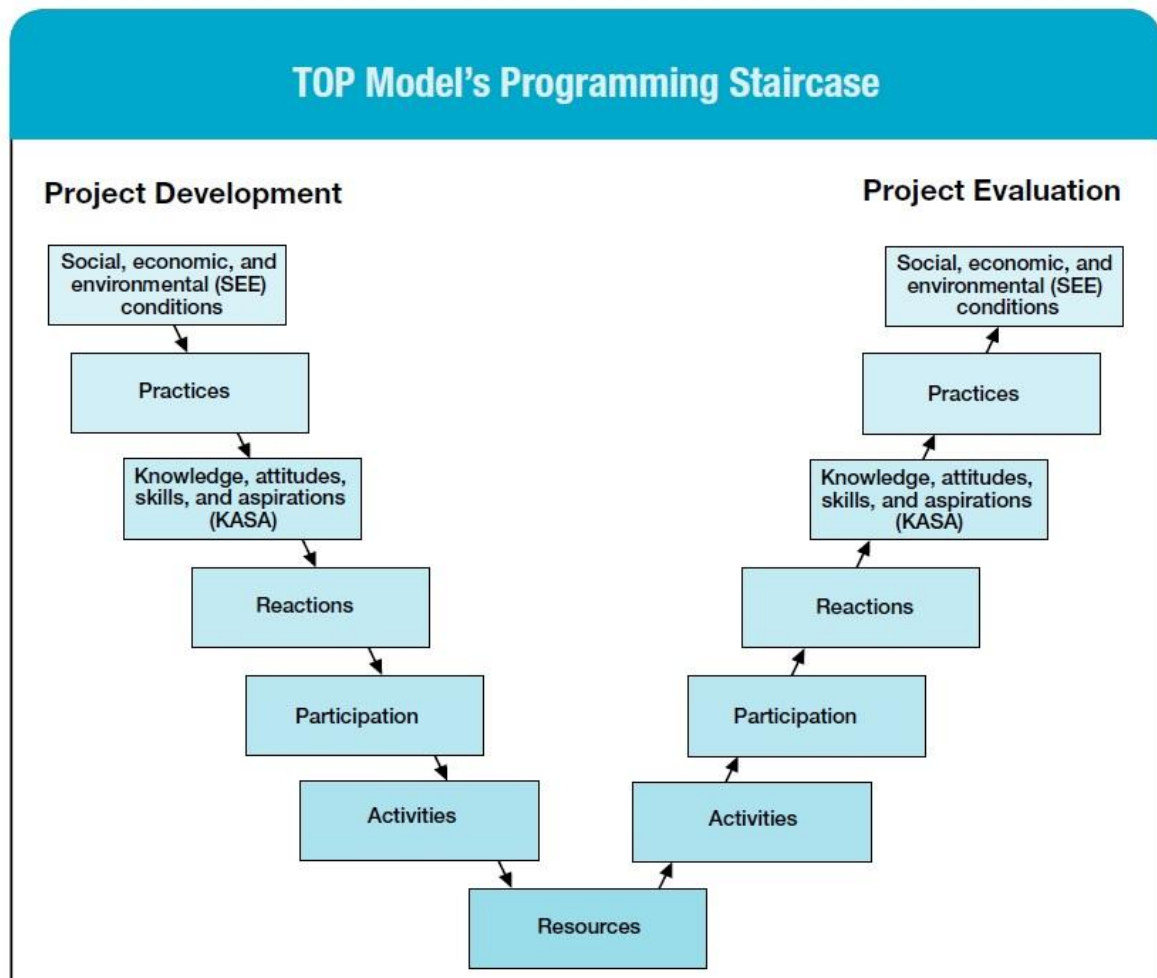


Figure 1.3. – A model for targeting program results

The developer of the educational project moves first from the upper left corner describing the social, economic and other conditions of the creation of the project, then describes the knowledge and skills that are necessary to obtain the results of the project, forms a list of the participants of the educational project, key activities and resources that are needed for them. These stages are included in the project development block. Further, during the implementation of the project, these stages are considered, but in reverse order, and the performance of the stages is evaluated based on quantitative or qualitative performance indicators.

The scheme of the life cycle of an educational project is also effective (Fig. 1.4). The first stage of the functioning of the educational project is its initialization, which includes the formation of critical documents that regulate the implementation of the project, the formation of the project's working team and the definition of their

functional responsibilities. The second stage is the planning of the educational project, which includes the following main tasks:

- creation of a Gantt chart with a list of all project tasks concerning time;
- formation of the project budget and its approval, determination of which funds are necessary to fulfill the tasks of the previous item;
- appointment of project task executors from the project team;
- creating a risk management plan and a communication plan within the team and with external stakeholders.



Figure 1.4. - Scheme of the life cycle of an educational project

The third stage is the implementation of the project, which includes effective management of the time and progress and quality of the implementation of tasks, management of the project budget and resource provision, ensuring collaboration between the executors of the educational project and communication with stakeholders, by organizing conferences, seminars, etc.

The fourth stage is monitoring and controlling project tasks, which is determined by change management in case it is necessary to make changes to the Gantt chart or modify the project plan.

The fifth stage is the completion of the project, which is determined by summing up the results, evaluation of the project results, as a rule, by an external evaluator,

preparation of reporting documentation with justification of possible ways of expanding the project results, and its sustainability in the future.

In this work, primary attention is paid to the planning and monitoring of the project, in particular to applying the competence method to the selection and evaluation of the activities of the project executors both before the project start and during its implementation. Achieving the planned results within the relevant deadlines depends on selecting highly qualified project executors. For the most part, in real projects, there is a subjective assessment of project executors by the manager. However, to ensure the high efficiency of the project, such evaluation must be automated in a certain way, in addition, the evaluation must be based on the actual results of the performers during the implementation of the project, i.e. dynamically. This guarantees quick correction and adjustment of the composition of project executors if their performance is low. For this, appropriate decision-making models should be developed. The decision is made by the person, in this case, the project manager. The solution may relate to changing the composition of the project work team or the executors of individual work packages, or managing time, tasks, and changes during project implementation. In addition, this approach will increase the quality of the project as a whole and the competence of the project executors, which is a relevant element of their proactive motivation.

Therefore, to ensure the high-quality implementation of an educational project, it is necessary to monitor its implementation thoroughly. Project monitoring is a complex process that requires an assessment of the project's potential. It should be understood that ensuring the appropriate potential of the project is possible thanks to practical cooperation and the level of competence of its executors. Therefore, an indispensable monitoring component should also be assessing project executors' performance indicators according to various work packages.

1.2. Peculiarities of the application of competence approaches in the management of educational projects

The last few decades have become turning points in understanding the importance of education development and educational projects to ensure the sustainability of the economy of the state and entire regions. Education development is one of the essential impulses that have enabled the rapid growth of the People's Republic of China and the economies of the Asian tiger countries: Singapore, Hong Kong, South Korea and Taiwan. During the last 60 years, these countries have grown annually on average twice as much as the world economy. In particular, the annual growth of the Asian tiger countries during this period was observed at 8-10%, while the world economy grew annually at 4-5%.

Although specific features for each of the countries ensured their rapid growth, most of them relate to reforming tax policy, fighting corruption, attracting international investors, and stimulating small and medium-sized businesses. However, one should also consider the effects of the development of technologies, the export of which has been key in developing these countries during the last decade. The formation of an effective high-tech economy is a consequence of an effective educational policy in the state, the involvement of scientists and scientific teams engaged in developing technologies, and investment in knowledge-intensive technologies. To ensure this, the state's educational policy must be balanced and aimed at achieving specific goals of ensuring the development of a high-tech economy. For this, the state should stimulate and motivate the organization of educational projects to develop the necessary competencies and skills of students of general secondary and extracurricular education institutions and higher education institutions.

It should be noted that this process, with a planned policy, has a distant effect. The results of educational policy reform in this direction will be noticeable later, after the end of the education cycle of the young generation. In the future, the state must make every effort to build and involve students and graduates in developing a high-

tech economy. Some graduates will ensure the training of a new generation with the necessary competencies.

The application of competency-based approaches in managing educational projects has several features that contribute to more effective achievement of educational goals and improvement of the quality of education. Here are some of them:

1. Orientation to the development of competencies. Competency approaches aim to develop students' real skills and abilities, which they will be able to apply in practical activities. Management of educational projects is based on creating conditions for forming key competencies, such as critical thinking, communication, cooperation, etc.

2. Interdisciplinarity. Competency approaches contribute to the fusion of knowledge and skills from different subject areas. The management of educational projects may involve the cooperation of different teachers or experts from different disciplines to achieve the project's goals.

3. Active educational activity. A competent approach in education assumes an active role of students in their learning. Management of educational projects can stimulate independence, research work, and solving actual tasks and problems.

4. Assessment by results. Assessment in competency-based approaches is usually aimed at assessing knowledge and students' ability to apply it. Management of educational projects can be based on the assessment of specific products or solutions that students develop during the work on the project.

5. Collaboration and communication. Competency approaches contribute to the development of cooperation and communication skills. Management of educational projects can involve participants in joint work, exchange of ideas and knowledge, which contributes to a deeper understanding of the material and joint solving of tasks.

6. Adaptation to real situations. Competency approaches allow students to apply acquired knowledge and skills in different contexts. Educational project management can include scenarios where students must solve real problems or adapt their knowledge to new situations.

The application of competency-based approaches to the management of educational projects in the People's Republic of China may differ depending on the specific educational policies applied in the country. However, there are certain general features:

- In recent years, the Chinese education system has been reformed in the direction of greater emphasis on the development of skills and the assimilation of theoretical knowledge. A competency-based approach can promote the development of key competencies such as critical thinking, communication, creativity and others.

- Application of competency-based approaches can include innovative learning methods, such as project-based learning, problem-based learning, collective work, etc. These methods contribute to more active educational activities of students and project executors and their practical application of knowledge.

- The Chinese education system is improving in preparing graduates for practical work in the labor market. A competency-based approach can help create conditions for forming practical skills and abilities required in the labor market.

- To successfully implement competency-based approaches, it is essential to develop an evaluation system based on indicators of competency development. Assessment can be aimed at analyzing work on projects, practical tasks and other practical efforts.

The development of technology is now very fast. What was in demand ten years ago may be irrelevant now. Therefore, the analysis and formation of graduates' competencies necessary for developing a high-tech economy must occur dynamically. Only those states that can find the right solution in these difficult conditions will be able to effectively develop technologically in the future and adequately apply the principles of strategic management. Studies described in works [15, 16] indicate that the key problems that arise in strategic management are related to ensuring the competencies of employees of organizations or executors of relevant projects. Therefore, implementing and effectively managing educational projects in a dynamic environment is only possible with a competency-based approach.

Competence can be considered a characteristic of an employee of an organization or a project executor. Moreover, competence is a peculiar type of human capital that can be transformed to achieve specific productivity in the relevant field under certain conditions. This term should not be confused with the term qualification, which is formed from the point of view of tasks and requirements that provide a particular set of works [17].

Competence also determines the ability of an individual or team to solve specific project tasks and the method of achieving its goals. This possibility can be set according to a formalized or informal subjective criterion [18]. In this case, it is possible to define a set of related activities that can, in a certain way, define specific competencies in the conditions of implementing an educational project or in the organization's activities. Tasks related to competencies:

- recruitment and career growth of employees, staff mobility;
- training, training and retraining, both internal and external;
- changing the organization's tasks, particularly expanding the number of jobs, diversification, job rotation, etc.

In the management of educational projects, executors' competence is crucial at the stage of their planning. The selection of project executors should correspond to their competencies, allowing them to effectively perform all stages of the project life cycle and obtain the planned result. The specified tasks, similar to the organization for an educational project, include:

- selection of executors of an educational project at the stage of its planning, professional growth of executors, development of their spectrum of competencies in the process of project implementation, which is also ensured by the mobility of executors (both internal and external);
- the training of performers is often an indispensable component of an educational project, that is, the essence of the educational project must correspond not only to the task of training interested groups but also the training of performers and project participants directly;

- since the project can dynamically change on the way to KPI implementation, these changes must correspond to the competence approach: the inclusion of new executors in the project, the appearance of new tasks for the execution of which it is necessary to involve existing executors following their existing competencies, etc.

These tasks can occur in combination with others and can be planned and unplanned. Thus, through the prism of the tasks of the educational project, the term "development of competences" acquires a broader meaning. For the development of competencies, an appropriate strategy is built that corresponds to personal goals and collective or organizational goals. Different strategies can be combined and combined. That is, the strategies for the development of personal competencies of the executors of the educational project should be coordinated with the development of competencies necessary for the project's successful completion in accordance with its goals. This practice of applying competence development strategies is widespread in the countries of Northern Europe [19].

The development of competencies should occur due to implementing a rational planning strategy that arises in response to increased requirements for project results or due to changes or adjustments of project goals. The strategy should include increasing the competencies or forming new competences, mainly through training [20].

Competencies of the employee, manager or leader and the organization are highlighted. Competence defines issues that the object or subject knows well and can effectively change, improve, and improve activities by applying knowledge on these issues. The competence of organizations determines those issues that concern the organization's activity as a whole or its departments. The organization's effective operation directly depends on its employees' competencies. Depending on the level and position of the employee, a specific and specific list of competencies that he must possess corresponds to him. The manager's competence includes issues related to management at a certain level of the organization following the organization's goals.

In the context of educational projects, the competence of project executors includes the range of issues in which they are knowledgeable and which arise from the goals of the work packages of the project and the goal of the project as a whole.

The development of competencies is a process of rational assimilation of knowledge and skills (new or improvement of existing ones). Moreover, this process can be controlled based on certain pedagogical and psychological approaches to learning and testing knowledge. This way, within a certain time, competencies are mastered following the subject's goals. This concept of competence development is dominant in education and is determined by the human capital theory [21].

The following features of competence development based on the theory of human capital can be singled out:

1. The development of competencies occurs as a natural reaction to investment in individual and collective education, which is determined by the company's goals at the local level and the needs of the state at the global level. In educational projects, the development of competencies occurs both directly as a result of the assimilation of knowledge, the development and structuring of which is the goal of the project and indirectly through the development of soft skills: teamwork, communication, etc.

2. The planning of competence development activities should be clearly defined, considering the company's goals, following the organization's development policy and strategy, etc. When applied to educational projects, the planning of competence development activities is regulated by describing project stages corresponding to a specific work package.

3. Making decisions about investing in an educational project, the purpose of which is the development of specific competencies, should have a clear justification, taking into account the opinions of stakeholders and considering possible costs and weak points. In general, SWOT analysis is often conducted for these purposes.

4. Competence acquisition is a rational process that can be evaluated and revised dynamically, considering already achieved results.

The study [22] describes the results of competence development at the individual level for almost 300 people. A factor analysis of the answers to the questions of the training results questionnaire was conducted and the following aspects of the influence on the acquisition of competencies were identified:

- emergence of motivation for learning (formation of increased interest in learning new knowledge);
- motivation for personal career development (new job, higher salary, greater independence, etc.);
- motivation for ensuring social development (increasing confidence, ensuring self-realization, etc.).

The study [23] continued the study. Moreover, the effects on the development of competencies in small organizations were considered:

- motivation regarding the ability to effectively perform current tasks;
- motivation to learn new knowledge that will help in completing tasks faster and more efficiently;
- increased understanding of work in general, greater responsibility and quality of work.

Thus, the need to develop competencies to stimulate motivation and increase interest and satisfaction with results can be traced here. Success in the development of competencies generally depends on a combination of factors [24]:

- previous experience with subjects, level of knowledge, education, etc.;
- formation and planning of the competence development program, implementation of this program;
- conditions of competition and rates of development within the organization, as well as the culture of the organization and the peculiarities of its management.

Similar factors can be identified when applied to educational projects.

In works [25 – 27], studies on motivating acquiring competencies in the educational process are given, and the factors that influence this process are formed.

A four-stage competence development model is known (Fig. 1.5). This model is a cycle of four components. A critical component is the orientation process, in which the conscious choice of which competencies the subject plans to develop is determined. In the case of the development of the competencies of the executors of educational projects, the choice of competencies is determined by their direct participation in this or that work package of the project. Another component of the cycle is the development of competencies, particularly as a result of group work on project tasks. Such a cycle of competence development is described in [28].

Separately, in the development of the competencies of the executors of the educational project, the influence of the competencies of the project leader or manager should be highlighted. Because his knowledge and productivity directly affect the effectiveness and potential of the project.

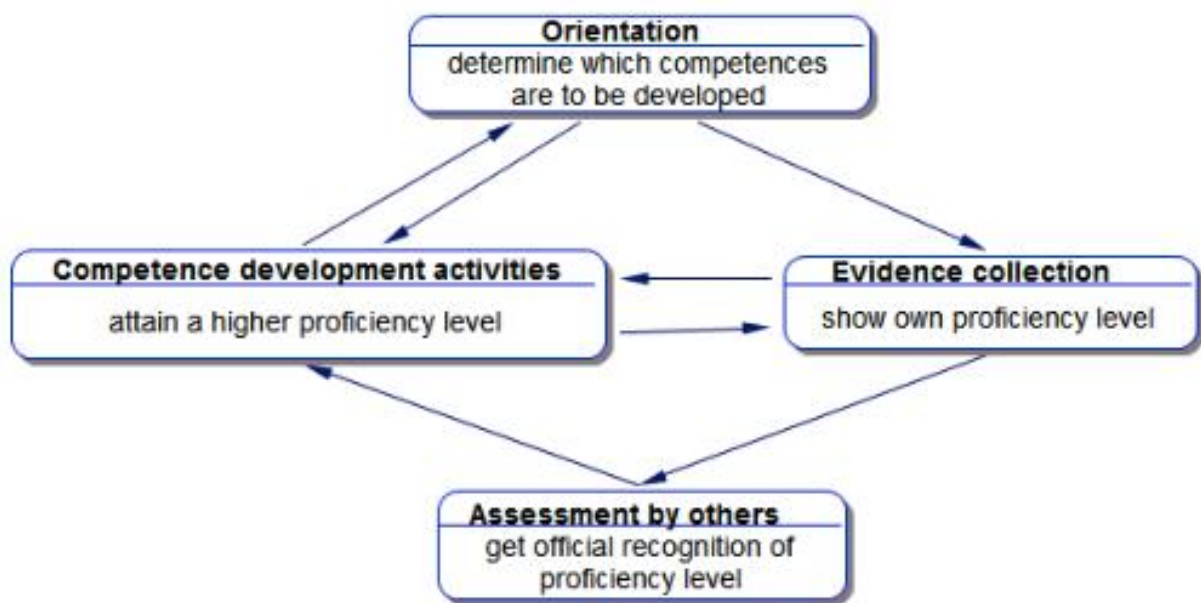


Figure 1.5. - Four-stage model of competence development

One of the standards providing a basis for the definition, assessment and development of project manager competence is PMI (2002) Project Manager Competency Development (PMCD) Framework – Second Edition (2002) [29]. It identifies key competency dimensions and identifies the competencies most likely to

influence project manager performance. The extent of this impact on project success may vary depending on factors such as project types and characteristics or organizational context and maturity. The PMCD Framework provides a common approach to the skills and behaviors required to develop project manager competency. Comparisons of the PMCD Framework with other PMI standards are shown in Figure 1.6.

Here it should be determined that competence can be described as a component of three separate concepts:

- 1) Knowledge of project management competence - what the project manager knows about project management.
- 2) Productivity of project management - what the project manager can achieve when applying his project management knowledge.
- 3) Personal competence - how the project manager works during the implementation of the project or activity; his attitude and main personality traits.

Today, the international standard ICB4 is in force, which defines the competencies of managers of projects, programs and portfolios [30].

PMI Standard	Key Document Integration Points
PMBOK® Guide Third Edition	Aligns with the structure, vocabulary, and definitions of the current PMBOK® Guide.
PMCD Framework – First Edition	Aligns with the 2002 version structure and philosophy.
PM Lexicon	Aligns with standard lexicon terminology
Combined Standards Glossary	Aligns with the Acronyms and Terms identified in the Glossary
PMP® Examination Specification	Aligns with the required knowledge and skills described. The PMCD Framework refers to the PMP Examination Specification for its definition of knowledge competencies.
Organizational Project Management Maturity Model (OPM3®)	Recognizes that the maturity of the organization may affect the performance of the project manager.
PMI’s Code of Professional Conduct.	Ensures the project manager operates under the professional conduct code.
Program and Portfolio Management Standards	Aligns with the Program and Portfolio Management Standards
Project Management Professional (PMP®) Role Delineation Study	Aligns with the research indicating required knowledge, skills, and other research data.
PMI’s Career Framework	Supports the Career Framework position that project management skills / competencies are the foundation of a project management career path.

Figure 1.6. - Comparison of the PMCD Framework with other PMI standards

It is important to note that a "competent" project manager alone does not guarantee project success. A project manager can successfully balance the competing demands of scope, time, cost, quality, resources, and risk, but project success depends on the enterprise's and project performers' maturity and capabilities. The project manager's competencies and the enterprise's maturity consistently lead to the project's success, and they can also affect various unforeseen changes [31] (Fig. 1.7).

Three levels of competencies are defined:

- Productive competencies (ability to initiate, plan, monitor, implement and report on the results of educational projects).
- Personal competencies (communication, leadership, professionalism, managerial skills, etc.).
- Knowledge related to project management.

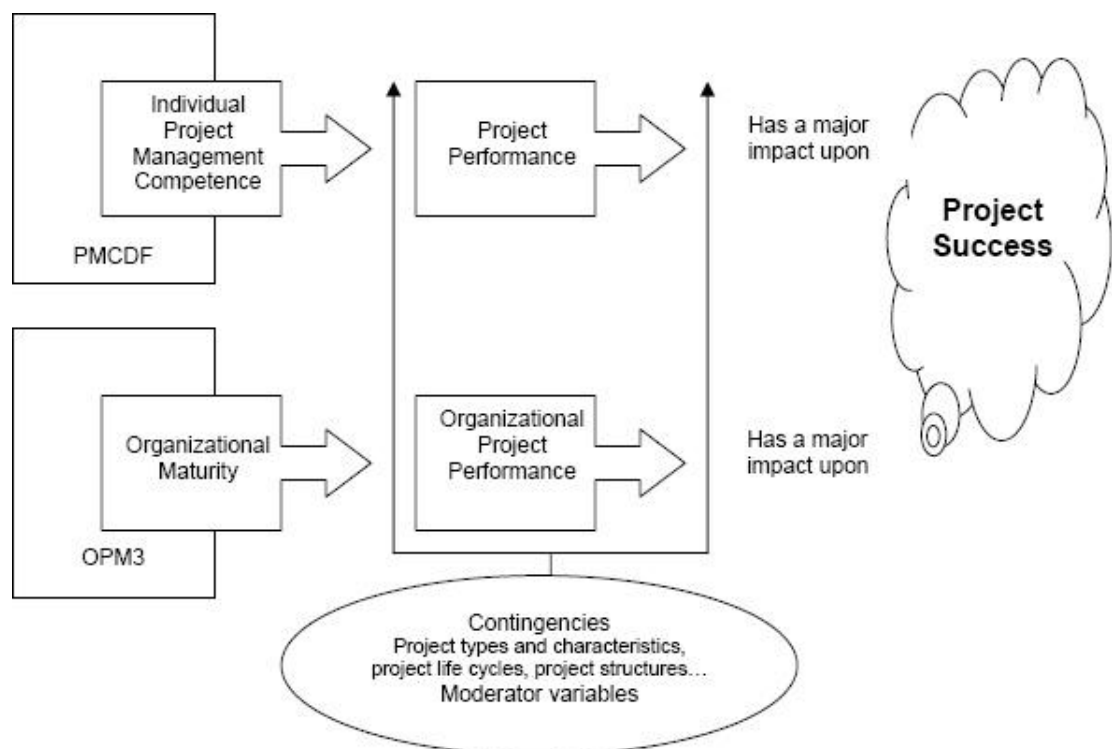


Fig. 1.7. - Project management competence and project success

The planning of the educational project should be carried out concerning the specifics of the development of competencies as a rational process of improvement and achievement of individual and collective goals of the executors of this project. With this in mind, understanding the process of competence development is the basis of effectively constructing an educational project aimed at effectively achieving goals. In addition, developing project executors' competencies can occur consciously through training and indirectly in teamwork.

The formation of competencies is determined by teamwork during project implementation. Moreover, this process can be tracked and measured in a certain way. A dynamic approach to evaluating the competencies of educational project executors is essential to ensure effective planning of an educational project.

Understanding the principles of building the competencies of project executors is an essential component for understanding the project's development.

1.3. Creating a team of educational project executors and determining their competencies

As already mentioned, the monitoring of educational projects is inextricably linked with the assessment of the performance of project executors. This paragraph reviews the principles of creating a project team and the specifics of determining their competencies.

An important mechanism for ensuring the stimulation of education and professional training is creating strategic partnerships and organizing educational projects. These projects are the basis of the implementation of joint initiatives to develop innovative methods of collegiate education, exchange of experience, and implementation of new practices to improve the quality of education at all levels for the relevant target groups. Competitive programs for forming strategic partnerships are actively implemented in the European Union (Erasmus+ program) [32]. They are created outside of this initiative by individual institutions of higher education for the development of educational activities. The creation of a single European space for

research and innovation, including in the field of education, takes place within the European scientific space [33]. The strategic goals determining the creation of this space are implementing reforms to promote digital transformation and expanding access to research by scientists with the possibility of exchanging knowledge with partners [34].

Formally, educational projects are created and functioning in educational and scientific information environments. These environments consist of ordered objects or entities, often with a multi-level structure, defined by their dynamically changing identifiers. Each executor of such projects develops in his own information environment, accumulating information about competencies and productivity and providing material for evaluating his potential in a specific field of activity. For the qualitative organization of the implementation of educational projects, an important role is played by the development of methods of building information environments of project executors, taking into account the competencies that are significant for the project of a specific direction in a dynamic environment. That is why it is essential to formalize the constituent information environments of performers, which should be based primarily on objective assessments of their activities.

The executors of the projects are mainly individual subjects of educational and scientific activity since they are primarily employees of higher or professional education institutions. Their activity is not limited to education but includes scientific, methodical, organizational, etc. Because of this, it is necessary to highlight those competencies of project executors that are key to the adequate performance of project tasks. Since the information environments of performers include all information about their activities, an important task is its formalization, taking into account the dynamics of the development of each performer. This is because the performer transforms and develops in his own environment, acquiring new knowledge and competencies over time.

Creating a competence-based method of forming information environments for educational project executors is an urgent direction. This will stimulate the development of innovative partnership cooperation in the educational sector and

increase the productivity and quality of educational and project activities.

The analysis of literary data should consider three dimensions of assessing the competence of an individual subject of educational activity or project executor: assessment of knowledge, productivity, and personal qualities. Assessment of knowledge involves allocating necessary knowledge and experience of the appropriate amount and their quantitative expression as qualifications of an individual subject of educational activity regarding the implementation of a specific educational project. Performance evaluation involves a quantitative interpretation of the effectiveness of the project work of an individual subject of educational activity during a certain period in the direction of a specific project. Assessment of personal characteristics involves considering the subject's ability to effectively carry out project activities, attitude to work, individual traits, sociability, etc.

The work [35] describes the properties of structural models of competencies in project management. The model of competencies in professional project management, proposed by the International Project Management Association [36], was chosen as the research object [35]. The method of studying adjacency matrices of oriented graphs was used to determine the properties of the structural models of competencies. However, the disadvantage of the proposed method is insufficient consideration of the specifics and sequence of project tasks, which may lead to an incorrect interpretation of the results, even if it is based on the current version of the international standard. Despite this, the standard [36] and the standard [37], reflecting the features of competence management, indicate that the qualifications of the project manager and his executors are directly correlated with the effectiveness of the project. In work [37], these factors are defined but not used. The work [38] describes the developed method of creating a project team, which takes into account the requirements of the project, the characteristics of individual candidates and the general competencies of the team as a whole, as well as the limitations of the project in terms of budget and labor intensity. The stages of building a project team in work [38] are the maximization of the competencies of the executors directly and the maximization of competencies taking into account the time and budget constraints of

the project. However, in [38], the set of performers' competencies is considered static and fixed at the assessment time.

A network approach to building a project team is considered in [39]. For this, the analysis of social networks is used, reflecting the connections between performers. In work [40], a social network is used for this, taking into account the reputation of performers. The work [41] describes an individually-oriented method of selecting subjects of scientific activity as executors of scientific and educational projects, taking into account the productivity of their scientific activity in the past and the structure of projects. However, the approaches described in works [39–41] do not consider the competence of potential executors. Still, they are based only on some components that determine the competence of the executor of an educational project. It should be understood that competencies tend to change over time. Accordingly, the mechanisms of competence development and erosion in an innovative project are described in [42].

The work [43] describes the concept of building information environments of subjects of scientific activity, which is based on the assessment of scientific productivity. That is, only the productivity component is taken into account, which, as already indicated, is one of the parts that form the competence of the project executor. In work [44], a set of competencies of potential performers is already used to form a project team, but the personal characteristics of performers and their performance are not considered. The expert evaluation method for team formation is considered in the work [45]. However, the project management staff needs to be considered in the work. Consideration of management personnel to increase the effectiveness of project team management based on the use of educational environment-oriented project-vector management methodology is described in [46]. The construction of an information communication system to implement this methodology for evaluating the productivity of subjects of scientific activity is described in [47]. However, works [46, 47] refer to a comprehensive evaluation of higher education institutions' activity, which also considers the educational component.

Also, in recent years, significant progress has been made in implementing sustainable development in the creation of educational programs of higher educational institutions as part of educational projects to improve the effectiveness of the educational process [48–51]. This especially applies to those projects where European managers or project grantors are from the European Union [52–54]. In works [55, 56], a study of competencies to ensure the sustainable development of universities was carried out. The works [57, 58] investigated ways to develop competencies through pedagogical approaches. However, research on this was limited to pedagogical approaches and how they can affect sustainable development competencies.

During the last ten years, the amount of literature devoted to discussing the issue of using competency-based approaches in implementing educational projects aimed at improving the quality of the educational process has been growing. From the perspective of learning, competencies are defined as a way of describing desired education [59–61]. They include cognitive, functional, ethical and personal dimensions [62] and link complex knowledge and skills [63]. Lists of competencies related to education for sustainable development have been proposed by several authors in recent years [63]. In particular, five general groups of competencies were proposed: systems thinking, anticipatory, normative, strategic and interpersonal competence. In work [64], 12 competencies are proposed — systemic thinking and coping with complexity, anticipatory thinking, critical thinking, acting justly and ecologically, cooperation in (heterogeneous) groups, participation, empathy and change of perspective, interdisciplinary work, communication and media use, planning and implementation of innovative projects, evaluation and tolerance for ambiguity and frustration. These competencies can be taken as a basis for assessing the level of personal competencies of the implementers of educational projects.

In the work [65], 12 competencies are proposed:

- Systemic thinking.
- Interdisciplinary work
- Anticipatory thinking

- Justice, responsibility, ethics
- Critical thinking and analysis
- Interpersonal relations and cooperation
- Empathy and change of perspective
- Communication and media use
- Strategic actions
- Personal involvement
- Assessment and evaluation
- Tolerance for ambiguity and uncertainty

To develop competencies to ensure the sustainable development of higher education institutions and the implementation of educational projects, a combination of different pedagogical approaches is necessary [66], allowing students to benefit from various learning processes [67 - 69].

Another critical component for ensuring the sustainability of the university's functioning and its projects is the provision and support of the diversity of project participants (gender, cultural origin, etc.) [70 - 73].

Therefore, taking into account the dynamics of transformation and development of the competencies of performers and the connection of this development with the tasks of a specific project still needs to be solved. To ensure effective planning of an educational project, it is advisable to build information technology to support decision-making. To ensure the flexibility of this system, it is proposed to apply the competence method of evaluating the benefits of project executors.

Since assessing project executors' competencies is complex, the assessment process can be formally automated by building information environments for executors with the competencies they have developed. Competencies in this context will be considered as a set of three components: assessment of knowledge, productivity and personal characteristics of the executors of educational projects. The formation of this information environment should take place dynamically, considering the performers' acquisition of new knowledge or the improvement of

existing ones. The environment should change, considering changes in performance indicators of performers: their publication of scientific publications and speeches at specialized conferences. The introduction of research elements into the project can significantly strengthen the sustainability of the project because the project results, if published, can later be used by other universities or project working groups. This, in turn, has a positive effect on the development of this direction in the region. The evaluation of the personal characteristics of the performers, which is also included in the information environment of the performers, is an essential indicator of the comfort of working with one or another performer in the team. This indicator is important because effective teamwork is the basis for ensuring the effectiveness of the project. It is essential to track any communication breakdowns within the project team. This impacts the adjustment of the composition of project executors if communication violations are critical and do not allow for achieving an effective project result within the specified period. The development of competence-based management methods in education is used in related research to ensure the quality of the educational process, the development of technologies for raising the rating of scientific research, the creation of organizational systems of open education and educational projects [74 - 114], etc.

Also, to ensure effective planning of an educational project, it is essential to develop methods and models for assessing the level of competencies that would consider comprehensively the knowledge, productivity and personal qualities of their performers. It is obvious that if we are talking about the fact that the evaluation takes place in dynamics, then it is essential to form these indicators in the information environment of performers in the form of discrete time series. Separately from the levels of competencies, methods of objective assessment of the performance of project executors and the project's potential should be developed to track whether its executors' performance impacts the project's potential. All this should be integrated into the information technology of decision-making support for the planning and monitoring of the educational project, which can be an effective tool for institutions of higher education, especially in the conditions of periodic distance learning.

An educational project can be of different scaling levels. For example, at the university level, such a project may involve a significant amount of material and human resources, the project may contain many work packages, each of which requires teams of competent performers. Also, the educational project can be local and operate at the level of a particular university department and relate, for example, to developing and implementing an optional course for certain educational groups of students or trainees. For example, starting older adults to create computer sites, or teaching students studying at a master's program in the organization of scientific projects, or implementing distance learning in specific courses of the educational program. For this, there is no need to attract significant resources. Selection of executors of such projects is much easier. But the monitoring of such a project, as well as the monitoring of a significant educational project, should be done according to the same conceptual scheme. The development of such a system is essential for the education system of the People's Republic of China because universities manage many educational projects and the number of students is significant. Monitoring the implementation of educational projects is necessary to maintain effectiveness while the funds for implementing such projects are allocated in full. The sustainability of the solutions proposed in work relates to creating information technology that would allow for quality monitoring of the implementation of educational projects in dynamics and regardless of scale. This will allow the state to plan a system of allocation of funds for implementing such projects or to form a system of financial motivation for high-quality results. And this, in turn, will have an impact on improving the quality of education of students and listeners of the developed modules, will increase the competence of project executors and, as a result, will increase the rating of the higher education institution in which such a project is implemented.

Conclusions to chapter 1

1. This section examines the peculiarities of the formation and implementation of educational projects in universities. Five stages are identified that determine the life cycle of an educational project, including initialization,

planning, implementation, monitoring and completion. It is indicated that for educational projects, an essential addition to these components is the use of the competence method of evaluating the performers of the educational project in dynamics. This will allow tracking the change in productivity ratings, knowledge level, and personal characteristics ratings of the project performers during the implementation of the educational project and, as a result, increase the effectiveness of the project.

2. The application of competence methods in implementing educational projects is described. Practices and experience of other universities. It was determined that the planning and monitoring of the educational project should be carried out concerning the specifics of the development of competencies as a rational process of improvement and achievement of individual and collective goals of the executors of this project. With this in mind, understanding the process of competence development is the basis of effective construction of an educational project aimed at effective achievement of goals. In addition, developing project executors' competencies can occur consciously through training and indirectly in teamwork.
3. It was established that the task of taking into account the dynamics of transformation and development of the competencies of performers and the connection of this development with the tasks of a specific project is unsolved. To ensure effective planning and monitoring of an educational project, it is advisable to build information technology to support decision-making based on competency-based methods. The development of such a system is essential for the educational system of the People's Republic of China, as universities manage many educational projects with a large number of students, which requires an innovative monitoring system. Moreover, such a system should be able to work out both large-scale projects and small ones, such as, for example, the implementation of a distance learning system within one or several courses.

4. The main elements and ways of building such monitoring information technology have been defined, which include the development of methods for forming the information environment of executors, the creation of methods and models for assessing the level of competencies, methods for assessing the performance of project executors and the potential of the project. The latter is necessary to monitor the possible influence of the growth of the level of competencies of the performers on the assessment of the potential of the educational project.

CHAPTER 2. METHODS OF FORMING INFORMATION COMPETENCE ENVIRONMENTS OF EXECUTORS OF EDUCATIONAL PROJECTS

2.1. Multiple model of identification of the educational project executor

As already mentioned, an educational project is an ordered set of processes represented by work packages or stages and integrated into the project structure. The processes have certain limitations in terms of resources, time and conditions for achieving a new quantitatively or qualitatively measurable value in the field of education. A project is a system with its own life cycle and needs to ensure the proper management level. Management of an educational project is a process of organization, planning, and quality control of the performance of project tasks following the project's structure to achieve the project's goals in the field of education. The functioning of the educational project occurs due to the achievement of goals by the project executors, each of whom dynamically develops in their information environments. The components of the information environments of the executors of educational projects are identifiers that determine their competence in the implementation of educational projects and are transformed in the activities of the executors in the given project or outside it. Therefore, such information environments should not be considered statically but dynamically, considering possible transformations over time.

Let's consider three dimensions of evaluating project performers' competencies: evaluating knowledge, evaluating performance, and personal characteristics of performers. This is explained by the fact that for evaluating potential performers of an educational project, these characteristics are sufficient for ranking the performers and are measurable. When evaluating knowledge, we highlight the levels of knowledge and experience regarding specific project tasks related to the corresponding work package. For example, the availability of project management certificates, and participation in seminars and conferences. The project manager forms the specified list of criteria when selecting executors. Evaluation of the performer's productivity involves a quantitative interpretation of the effectiveness of the project work during a certain period in the direction of the educational project. For example, the number of projects in which the performer participated and their role, the presence of scientific articles within the project's scope in the relevant journals. The assessment of personal characteristics involves taking into account the subject's ability to perform activities qualitatively: attitude towards the performance and timeliness of specific tasks of the work package, individual traits of the performer, sociability, etc. The selection of educational project executors is a process aimed at forming an effective project implementation team of specialists in educational activities. For this, it is necessary to form the information environment of potential performers. This can be done based on the competence method.

The result of implementing the educational project is the acquisition of new fundamental or applied knowledge in the field of education. Moreover, this process is collective. Accordingly, evaluating the project by considering the information environment of a specific executor of the educational project, such as a manager, without considering the environments of other executors is incorrect. It should also be understood that educational activity is only possible with scientific activity. These are two complementary processes that, together with the results of activities, form an informational, educational and scientific space.

According to the described concept, the competence environment of the executor of the educational project includes the executor and retrospective

information from the identifiers that determine these executors and is formed based on the results of their educational activities and competencies.

The hypothesis of the study, as noted, is that the progressive, dynamic development of the competencies of the executors of educational projects impacts the productivity of these projects.

The productivity of projects is a quantitative indicator of effectiveness. This concept is introduced to determine the quantitative measure of the project's achievements following the assigned tasks. The project's potential is determined by the accumulated productivity of the project executors. It indicates the possible values that can be obtained in the case of continuing research in this project.

Let $E = \{e^1, e^2, \dots, e^m\}$ – the set of executors of some educational project A, m – the number of executors. Executors are mostly individual subjects of educational and scientific activity: employees of institutions of higher and professional education. Each element of the set E corresponds to a trio of competencies

$$K(t), P(t), I(t),$$

the value of which varies discretely over time. If t_0, t_1, \dots, t_{w-1} are the moments of time at which the values of the indicated indicators are fixed, t_0 is the initial moment of time. Then you can write down the time series of evaluations of the competences of the performer e_j :

$$K^j = (K_0^j, K_1^j, \dots, K_{w-1}^j) = (K^j(t_0), K^j(t_1), \dots, K^j(t_{w-1})),$$

$$P^j = (P_0^j, P_1^j, \dots, P_{w-1}^j) = (P^j(t_0), P^j(t_1), \dots, P^j(t_{w-1})),$$

$$I^j = (I_0^j, I_1^j, \dots, I_{w-1}^j) = (I^j(t_0), I^j(t_1), \dots, I^j(t_{w-1})),$$

where K^j is a discrete time series of evaluation of the performer's knowledge e_j educational project A in the field of education, according to the tasks of project A, which this performer must perform,

P^j is a discrete time series of performance evaluation of performer e_j educational project A,

I^j is a discrete time series of evaluation of the personal characteristics of the

performer $e_j, j = \overline{1, m}$.

Thus, the executor of the educational project A at the i -th moment of time $i = \overline{0, w-1}$ is represented by a set of identifiers that define it:

$$e_i^j = (K_i^j, P_i^j, I_i^j), j = \overline{1, m},$$

or matrix of competency assessments

$$M(e_w^q) = \begin{pmatrix} K_0^q & P_0^q & I_0^q \\ K_1^q & P_1^q & I_1^q \\ \vdots & \vdots & \vdots \\ K_{w-1}^q & P_{w-1}^q & I_{w-1}^q \end{pmatrix},$$

for the q^{th} performer.

These identifiers are not limited to the assignment of the information environment of the executor of the educational project. However, after calculating the specified parameters, it is possible to solve problems that will increase the efficiency of project implementation. Assessments of performers or competencies obtained in educational projects, in the process of their implementation, form a system of values that performers acquire in the process of their own activities.

If

$$F: E \rightarrow j^n,$$

then it is possible to form a discrete time series of values for the educational project A, which is obtained due to the activities of performers e^j . That is, the value chain for project A, provided by the executor e^j , looks like this:

$$\{F(e^1), F(e^2), \dots, F(e^m)\}.$$

Accordingly, the total value that educational project A will receive consists of the sum of values for each performer, i.e.:

$$F_A = \sum_{j=1}^m F(e^j).$$

If we consider the change of identifiers over time, it can be determined that the value chain for project A, provided by the performer e^j at the i -th moment of time,

looks like this:

$$\{F(e_i^1), F(e_i^2), \dots, F(e_i^m)\}.$$

Or for the q-th executor of the educational project, it is possible to highlight the values that he gives to project A:

$$\{F(e_0^q), F(e_1^q), \dots, F(e_{w-1}^q)\}.$$

Moreover, the accumulated value that educational project A will receive is determined as follows:

$$F_A(t_i) = \sum_{j=1}^m F(e_i^j), i = \overline{0, w-1}.$$

It can be assumed that the evaluation of the results of the educational project $F_A(t_i)$ will depend on the value e_i^j . Also, the dynamics of changes in values $F_A(t_i)$ can indicate the potential evaluation of the project evaluator.

Therefore, the executor of the educational project is determined by a trio of identifiers at the moment of time t_i , $i = \overline{0, w-1}$. This is shown schematically in Figure 2.1.

Each executor accumulates his competences to create values for a certain project A in which he participates. In turn, the performer's participation in this project allows for an increase in identifiers (Fig. 2.2.): at the moment of time t_i : $e_i^q = (K_i^q, P_i^q, I_i^q)$, and at the moment of time t_{i+1} : $e_{i+1}^q = (K_{i+1}^q, P_{i+1}^q, I_{i+1}^q)$,

where

$$K_{i+1}^q = K_i^q + \Delta K_{i+1}^q,$$

$$P_{i+1}^q = P_i^q + \Delta P_{i+1}^q,$$

$$I_{i+1}^q = I_i^q + \Delta I_{i+1}^q,$$

ΔK_{i+1}^q – assessment of the growth of the identifier of the performer's knowledge e^q at the moment of time t_{i+1} , $\Delta K_{i+1}^q > 0$,

ΔP_{i+1}^q – estimation of the growth of the performer's productivity identifier e^q at

the moment of time t_{i+1} , $\Delta P_{i+1}^q > 0$,

ΔI_{i+1}^q - assessment of the increase in the identifier of the performer's personal qualities e^q at the moment of time t_{i+1} , $\Delta I_{i+1}^q \in$ since the assessment of personal qualities depends on the subjective opinions of other performers, the amount of the increase can be negative.

The model of interaction of the educational project executor with project A is shown schematically in Figure 2.2.

Based on the model of identification of the executor of the educational project and his interaction with the project, we will get that the process of changing the identifiers of the executor occurs constantly in the process of interaction with the project. The contractor provides his experience and the results of his work, contributing to the project results. In turn, participation in the project improves knowledge, increases the performer's productivity, and influences the performer's personal qualities. Since all projects are implemented in a team, interaction takes place at the level between performers. Moreover, the value for project A, in which both performers participate, is formed by each performer separately (Fig. 2.3.).

The described connections are important, as their construction contributes to the correct definition of the informational competence environments of the executors of educational projects. Because we believe that these environments are dynamically changing, it is critical to understand the relationship between actors in a project and the relationship between actors and the project itself. This is necessary to understand the values that they will be able to provide each other in the process of transformation.

Executor e^q

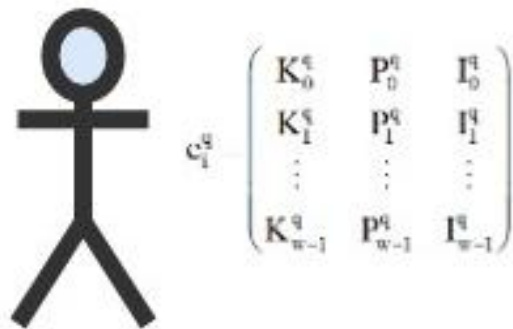


Figure 2.1. – Model of identification of the executor of the educational project

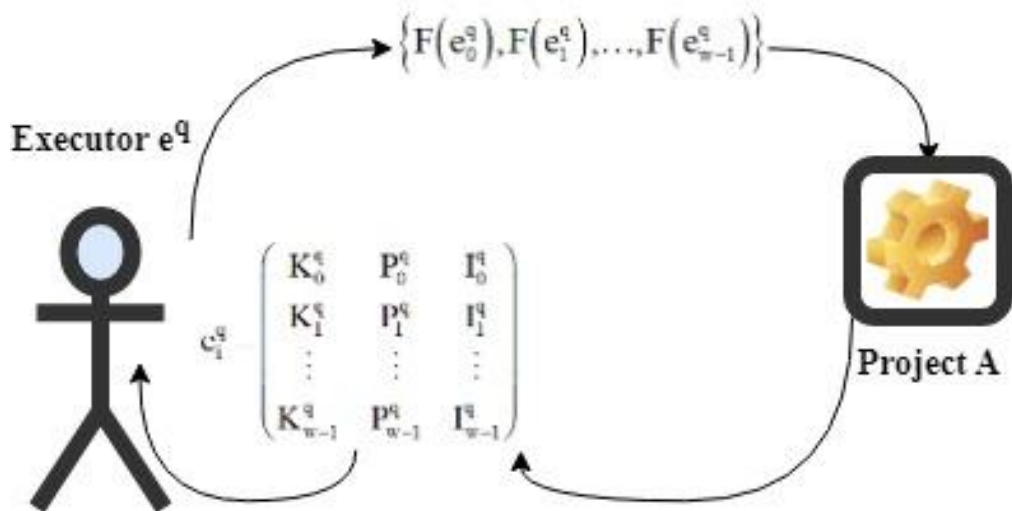


Figure 2.2. – Model of interaction of the executor of the educational project with project A

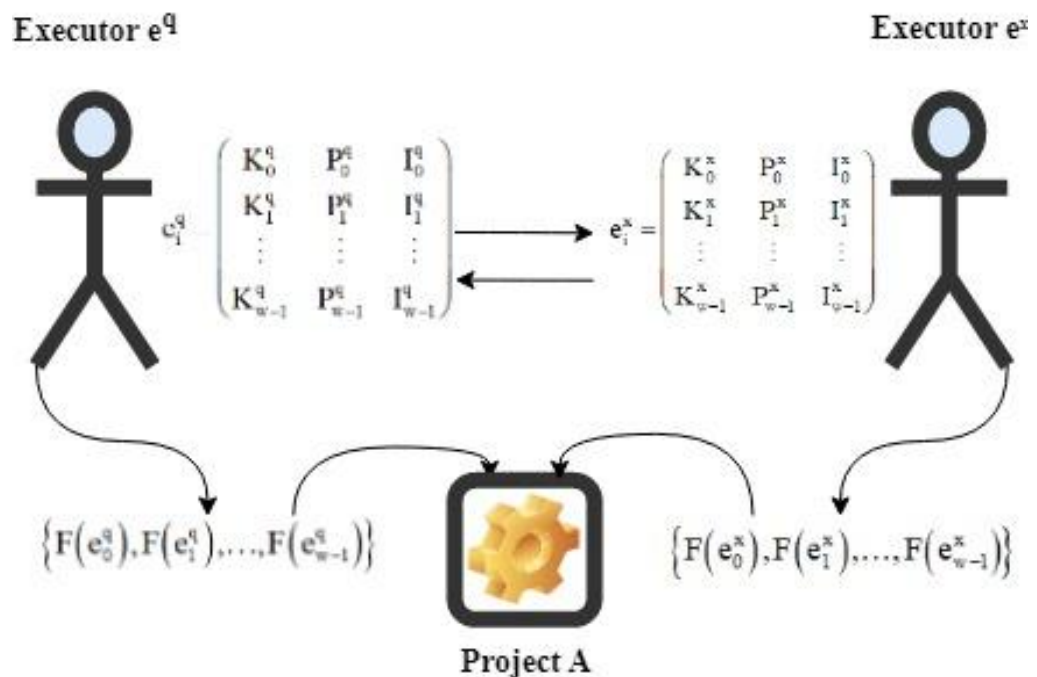


Figure 2.3. – The model of interaction between the performers of the team of the educational project A

The described structure and composition of the identifiers of educational project executors are at the basis of the formation of their information competence environments. Ensuring the effective implementation of educational projects depends on understanding the principles of formation and change of the components of the information environments of the executors of these projects. The theory of sets was used to create multiple models of identification of information environments of educational project executors.

2.2. The method of formation of informational competence environments of executors of educational projects

As already mentioned, the information competence environment of educational project executors consists directly of executors and information about their

competence. In order to understand the principles of formation of an informational competence environment, it is necessary to consider the model of transformation of the executors of educational projects. Let's assume that the performer e_i^q at the time t_i has accumulated a number of competencies $e_i^q = (K_i^q, P_i^q, I_i^q)$. Accordingly, the executor provides values for project A in which he participates, i.e

$$F_A(t_i) = F(e_i^q) + \sum_{j=1, j \neq q}^m F(e_i^j),$$

where $F_A(t_i)$ is the value provided by the performer e_i^q at the moment of time t_i for the project A, $\sum_{j=1, j \neq q}^m F(e_i^j)$ is the total value that project A receives at the moment of time t_i from all executors of project A, excluding executor e_i^q .

Participation of the performer e_i^q in project A leads to accumulation in it experience and competences at the level of knowledge, productivity and personal qualities. Moreover, knowledge and productivity can only accumulate, and the level of personal qualities can change both positively and negatively. That is, there is a transformation of the executor of the educational project, moreover it is possible to change competencies express at a time t_{i+1} in increments:

$$e_{i+1}^q = (K_i^q + \Delta K_{i+1}^q, P_i^q + \Delta P_{i+1}^q, I_i^q + \Delta I_{i+1}^q),$$

then

$$K_{i+1}^q = K_i^q + \Delta K_i^q$$

$$K_{i+2}^q = K_{i+1}^q + \Delta K_{i+1}^q$$

$$K_{i+2}^q = K_i^q + \Delta K_i^q + \Delta K_{i+1}^q$$

$$K_{i+3}^q = K_i^q + \Delta K_i^q + \Delta K_{i+1}^q + \Delta K_{i+2}^q,$$

...

$$K_w^q = K_0^q + \sum_{i=0}^{w-1} \Delta K_i^q$$

where K_0^q is the initial competence of knowledge performer e_i^q ,

K_w^q - initial competence _ productivity performer e_i^q at the moment of time t_w .

And logically, we will show how competence about productivity is determined on the basis of initial productivity :

$$P_1^q = P_0^q + \Delta P_0^q$$

$$P_2^q = P_1^q + \Delta P_1^q$$

following P_1^q into the formula for P_2^q , we get about:

$$P_2^q = P_0^q + \Delta P_0^q + \Delta P_1^q$$

$$P_3^q = P_0^q + \Delta P_0^q + \Delta P_1^q + \Delta P_2^q$$

...

$$P_w^q = P_0^q + \sum_{i=0}^{w-1} \Delta P_i^q$$

where P_0^q is the initial competence productivity performer e_i^q ,

P_w^q - initial competence _ productivity performer e_i^q at the moment of time t_w .

For the competence and level of personal qualities of the performer , the formulas are identical, but you need to remember that rate of increments $\Delta I_i^q \in \mathbb{R}$, $i = \overline{0, w}$, i.e

$$I_1^q = I_0^q + \Delta I_0^q$$

$$I_2^q = I_1^q + \Delta I_1^q$$

$$I_2^q = I_0^q + \Delta I_0^q + \Delta I_1^q$$

$$I_3^q = I_0^q + \Delta I_0^q + \Delta I_1^q + \Delta I_2^q$$

...

$$I_w^q = I_0^q + \sum_{i=0}^{w-1} \Delta I_i^q$$

where I_0^q is the initial competence and the level of personal qualities performer e_i^q ,

I_w^q – initial competence and level of personal qualities performer e_i^q at the moment of time t_w .

Let's define time series of accumulated increments assessments of the

performer's competences e_i^q for three levels :

$$\Delta K^q = \{k_0^q, k_1^q, \dots, k_{w-1}^q\},$$

where

$$k_0^q = \Delta K_0^q$$

$$k_1^q = \Delta K_0^q + \Delta K_1^q$$

$$k_2^q = \Delta K_0^q + \Delta K_1^q + \Delta K_2^q$$

...

$$k_{w-1}^q = \sum_{i=0}^{w-1} \Delta K_i^q,$$

where ΔK^q is the time series of the accumulated increments of the performer's e^q competence ratings according to the level of knowledge ratings in the process and implementation of project A at discrete moments of time t_0, t_1, \dots, t_{w-1} ,

$$\Delta P^q = \{p_0^q, p_1^q, \dots, p_{w-1}^q\},$$

where

$$p_0^q = \Delta P_0^q$$

$$p_1^q = \Delta P_0^q + \Delta P_1^q$$

$$p_2^q = \Delta P_0^q + \Delta P_1^q + \Delta P_2^q$$

...

$$p_{w-1}^q = \sum_{i=0}^{w-1} \Delta P_i^q,$$

where ΔP^q is the time series of the accumulated increments of the performer's e^q competence ratings according to the level of productivity ratings and in the process and execution of project A at discrete moments of time t_0, t_1, \dots, t_{w-1} ,

$$\Delta I^q = \{y_0^q, y_1^q, \dots, y_{w-1}^q\},$$

where

$$y_0^q = \Delta I_0^q$$

$$y_1^q = \Delta I_0^q + \Delta I_1^q$$

$$y_2^q = \Delta I_0^q + \Delta I_1^q + \Delta I_2^q$$

...

$$y_{w-1}^q = \sum_{i=0}^{w-1} \Delta I_i^q,$$

where ΔI^q is the time series of the accumulated increments of assessments of the performer's e^q competencies according to the level of assessments of personal qualities in the process and implementation of project A at discrete moments of time t_0, t_1, \dots, t_{w-1} .

That is, matrix of the performer's competencies e_i^q at the moment of time t_w is defined as follows :

$$M(e_w^q) = \begin{pmatrix} k_0^q & p_0^q & y_0^q \\ k_1^q & p_1^q & y_1^q \\ \vdots & \vdots & \vdots \\ k_{w-1}^q & p_{w-1}^q & y_{w-1}^q \end{pmatrix}.$$

Thus the achievement performer e^q in education projects A are determined by the matrix of ratings competencies $M(e_w^q)$. The first row of the matrix will determine the initial levels of competencies, the last row - the evaluation of competencies at the current moment.

The value provided by the performer e^q for the educational project A at a moment in time t_i may be determined by the method of linear convolution :

$$F(e_i^q) = \alpha k_i^q + \beta p_i^q + \lambda y_i^q,$$

$$\alpha + \beta + \lambda = 1, \alpha, \beta, \lambda \in [0, 1].$$

It can be assumed that if E is the set of executors of educational projects, then

$$\exists q \in E, \forall t_r \in T, \frac{F(e_r^q)}{F(e_{r-1}^q)} > 0 \Rightarrow \frac{Q_r^A}{Q_{r-1}^A} \geq 0,$$

where Q_r^A is the evaluation of the monitoring results of project A at the moment of time t_r . Moreover this one the rating depends on the values that all performers

provide $F_A(t_r)$ to the project in a comprehensive manner . That is, progressive dynamic development of the competences of the executors of educational projects affects the potential of these projects .

It should be noted that values are also experienced within the informational competence environment between performers, which can be reflected in increases in their competence ratings. In addition, the increase in the competencies of the performers takes place at the expense of other projects in which they participate. In fig. 2.4. the model of the transformation of the executors of educational projects and their interaction within the information competence environment and with the projects they perform is depicted.

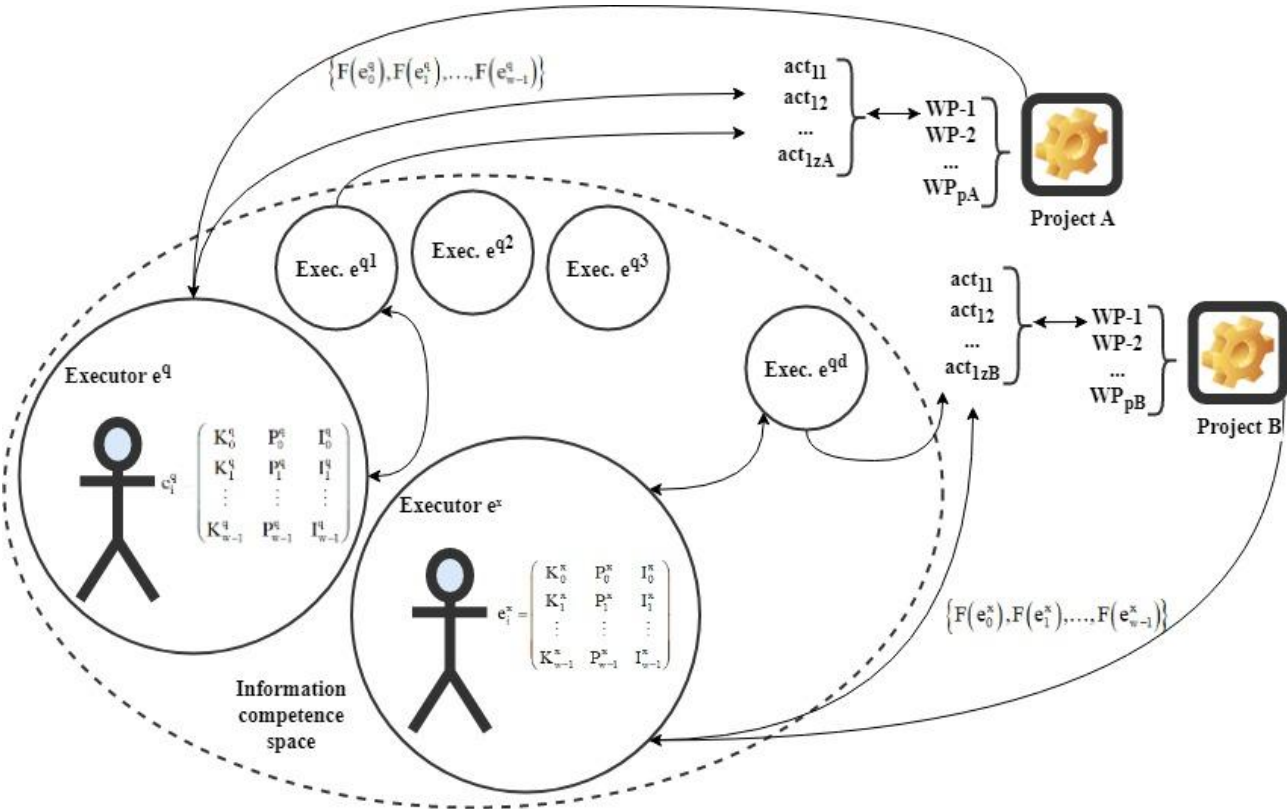


Figure 2.4. – Model of transformation of educational project executors

From Figure 2.4. it can be seen that the executors of educational projects convey their values by performing specific actions (acts), defined by the relevant work package (WP) of educational projects. In turn, participation in the project allows the performer to transform by increasing knowledge, productivity, and personal qualities

within his own set of competencies.

The method of forming informational competence environments for educational project executors consists of the following steps:

1. Determination of the executor of the educational project and his identification based on the identification model.
2. Formation of the components of his competencies $e_i^q = (K_i^q, P_i^q, I_i^q)$ based on objective information about the performer's knowledge, productivity and personal characteristics.
3. Clarification of the components of the competencies of the executors of educational projects after a certain period, for example, 1 month, i.e. ensuring the dynamics of indicators of the executors of educational projects and their transformation.

In case of the involvement of the executor in other projects, the existing environment can be used as a basis. There is a relationship between the project environment and the performers.

Let's consider in more detail the components of evaluations of the competencies of the executors of educational projects. The first component is the evaluation of the performers' knowledge.

There are several ways in which you can confirm the assessment of the knowledge of the performers. Some of them are:

1. Certification: Performers can pass certification exams that determine their knowledge level in project management or another field that corresponds to the direction of the educational project.
2. Portfolio or CV: Performers can present their work in a portfolio or include it in a CV indicating their work experience in the field corresponding to the direction of the educational project.
3. Reviews: Other users can leave reviews about the work of performers, which will help determine their abilities and level of professionalism.
4. Quizzes: Performers can take quizzes that assess their knowledge in a specific

area.

5. Interaction with the performer: Talking to the performer can help determine their knowledge and experience in the field relevant to the direction of the educational project. Questions and discussions of the project can give an idea of how familiar the performer is with the topic and how experienced and knowledgeable he is in completing the task of the educational project.

Among the specified list, it is possible to objectively confirm the assessment of knowledge only based on the first and second points, that is, confirmation of knowledge by certificates and the experience of the performer in other similar projects, which is indicated in his CV with a link to the website of the projects with information about the performer's duty in them. The second item will be included in the following component: performer performance. The third item will be evaluated separately as a separate component of the competency assessment. Test tasks are an adequate practice for confirming the level of knowledge, however, when forming a project team, it is unsuitable or used extremely rarely. Regarding the last point, the interaction with the performer effectively confirms the level of knowledge, but it is subjective. This item can only be used. If the representative of the recruiting company communicates with the potential executor to independently assess the capabilities and knowledge of the executor in the implementation of the project. In addition, this point does not allow for tracking the change in the level of competence of the performer to a sufficient extent.

This study chose the performer's CV with information about the passed certification as the basis. The certification of the performer increases with each new educational project because the result of successful completion of educational modules for both students and teachers is confirmation of participation in the relevant activity with the help of a certificate. A report at seminars, conferences can also be confirmed with a certificate. Indirectly, the level of knowledge can be influenced by the rating of the university where the performer works. In the best universities, mostly good specialists work. Also, the level of knowledge is affected by the scientific degree and titles received by the performer. To automate the process of

calculating the assessment of the level of knowledge of the educational project executor, the scale presented in Table 1.1 is used.

The performance assessment according to the proposed scheme takes into account the Hirsch index of the performer according to the Scopus system, the number of scientific publications indexed in the Scopus database that have been indexed in the last 5 years, the number of citations of scientific publications in the last 5 years, the number of created educational modules (authorship is confirmed on the project website) , the number of projects in which the performer participated (confirmed on the project website). All data selected for evaluation are reliable and open, they can be checked by the evaluator and automatically downloaded by the system from project sites or scientometric databases. The scale presented in Table 2.1 is used to automate the process of calculating the assessment of the educational project executor's productivity level.

Table 2.1

Indicators of evaluation of the competencies of educational project executors

Criterion	Indicators	Relative weight, %
Assessment of knowledge	– the number of certificates in the direction of the project with a confirmed score	15
	– number of certificates for participation in conferences, seminars	5
	– academic degree and title in the direction of the project topic	5
	– ranking of universities in which the performer works according to the QS system	5
Performance evaluation	– Hirsch index (Scopus)	5
	– the number of scientific publications indexed in the Scopus database, indexed during	10

	<p>the last 5 years</p> <ul style="list-style-type: none"> – number of citations of scientific publications over the past 5 years – number of educational modules created (authorship confirmed on the project website) – number of projects in which the performer participated (confirmed on the project website) 	<p>5</p> <p>10</p> <p>10</p>
Evaluation of personal characteristics	<ul style="list-style-type: none"> – modified personality assessment test – evaluation of the executor by other executors of the project 	<p>20</p> <p>10</p>

The third component of the competence assessment is determined based on a questionnaire based on a system similar to the OPQ (Occupational Personality Questionnaire). The OPQ system is a tool designed to assess a person's personality traits in the context of their professional activities. Questionnaire according to the OPQ system, consists of the following stages:

1. Introduction to the OPQ system. To start the questionnaire, you need to familiarize yourself with the principles of the system, which will help you better understand the task and allocate time for answers.

2. Preliminary questions. At the beginning of the test, there may be questions about personal data, such as age, gender, education, etc.

3. Questionnaire. The main part of the test consists of more than 200 questions that relate to various aspects of a person's behavior and personality. Answers should be given based on your first instinct, without thinking for a long time, because the OPQ system requires quick and accurate answers.

4. Results. After passing the test, you receive a list of professional qualities and recommendations on those aspects that should be improved to achieve more

successful results at work.

5. Consultation with a specialist. Suppose you have questions about the results of the survey. In that case, you can consult a specialist who will help you understand and analyze the results and offer recommendations for further development.

The essence of the OPQ is to assess the preferences and abilities to perform the tasks of a specific executor of an educational project. This test does not assess knowledge and abilities. According to the recommendation of the test developers, it should be taken every year, because the preferences and style of performers can change over time, and in two years the test results will already be outdated. The OPQ does not simply assess a person's characteristics but those that relate to task performance in the relevant job. The OPQ measures relating to people, thinking style, and present emotions and feelings. For a project manager, the test is important because it helps identify leaders among performers and the best candidates for the appropriate role in the team. Typical questions for evaluating relationships with people:

1. Do you prefer to take the initiative, or would you rather support another performer in the team who would take the initiative?

2. Do you consult with other team members before making a decision?

Questions for assessing thinking style:

1. Do you like working with numbers and analyzing data?

2. Do you tend to understand the motives and behavior of other people?

Questions about the definition of emotions:

1. Do you get nervous before important events?

2. Do you like competitive situations at work?

In general, as can be seen from the typical questions of the OPQ test, they are general. However, to evaluate the characteristics of educational project executors, specific wording should be included in the questions, which relate to the specifics of the implementation of such projects, the development of modules, the organization of educational events, etc. Therefore, a modified personality assessment test is proposed to assess the third component of performers' competencies (table 2.2.). The

performers' answers are recorded on a scale from 1 to 10 points.

Also, in addition to the modified personality assessment test, it is necessary to evaluate the performer based on the results of his work in the team. For this purpose, a questionnaire is drawn up, to which project team members answer about the comfort of working with one or another team member, his professionalism, timeliness of communication, etc. (table 2.3.).

Table 2.2

A fragment of the questions of the modified personality assessment test

Criterion	Question
Evaluation of relations with people	<ol style="list-style-type: none"> 1. Do you perform the project manager's tasks yourself or ask other team employees to do it? 2. Do you prefer to take the initiative or would you instead support another performer in the team who would take the initiative? 3. Do you consult with other team members before making a decision? 4. Are you comfortable spending time in the office or do you prefer to work online? 5. Is it easy for you to communicate with strangers?
Assessment of thinking style	<ol style="list-style-type: none"> 1. Do you enjoy working with the creation of educational modules, developing practical exercises and lecture notes? 2. Do you like teaching students, answering questions, and accompanying the educational process? 3. Do you enjoy developing tests based on the key tenets of technology? 4. Do you prefer established work methods or are you looking for new, innovative ways of working? 5. Do you enjoy dealing with other people's thoughts and feelings?

Evaluation of feelings and emotions	<ol style="list-style-type: none"> 1. Are you nervous before important events, such as a lecture with a new group of listeners? 2. Do you trust other team members or are you wary of them? 3. Do you like competitive situations and need to win? 4. Do you feel dissatisfied when your work is criticized in the project team? 5. Do you feel satisfaction from being interested in the lecture topic in the group of your listeners?
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Table 2.3

A fragment of questions on the evaluation of the performer by other performers of the project

Question
<ol style="list-style-type: none"> 1. Does team member A respond to your request on time? 2. Are you comfortable working with team member A? 3. Evaluate the professionalism of team member A? 4. Would you be willing to jointly carry out a separate work package of the project with a member of Team A? 5. Would you be satisfied if a team A member became the project manager?

The formed competence assessment system is the basis for forming informational competence environments of educational project executors. Such environments are constantly changing according to the results of updated calculations, and the evaluations of the performers of educational projects change the results.

Conclusions to chapter 2

1. This section describes the model of identification of the executor of the educational project, the model of the interaction of the executor of the

educational project with another project, the model of the interaction of the executors of the educational project team. These models differ in that the executor in them is not static, he accumulates experience from participation in other projects, giving in turn, values to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers. The model of identification of the executor of the educational project is at the basis of the formation of information competence environments.

2. A method of forming informational competence environments of participants in educational projects has been developed, which differs in the complexity of the approach to assessing the level of competencies, taking into account the level of knowledge, productivity and personal characteristics of the performers. In addition, due to the continuous transformation of performers, the information competence environment is transformed along with their performers. Determining the mechanism of this transformation is essential for effective monitoring of educational projects.
3. Identified models and features of building an information competence environment are the basis for further evaluation of the performance of educational project executors and the project's potential and, in general, are an essential stage of ensuring the monitoring of the educational project as a whole.

CHAPTER 3. METHODS OF MONITORING EDUCATIONAL PROJECTS BASED ON THE DYNAMICS OF THE INFORMATION COMPETENCE ENVIRONMENT

3.1. The method and model of assessing the level of competences of educational project executors

First, let's define the concept of competence used in constructing the method. Competence of the executors of educational projects is a set of knowledge, skills, abilities, possessions and personal qualities that allow a person to effectively and professionally perform tasks and achieve set goals in a specific area of the educational process.

Competence can include various aspects, such as:

- Technical skills. Knowledge and skills related to a specific activity. For example, in the case of an educational project, it can be the ability to develop educational programs, use modern technologies in education, assess students' knowledge, etc.
- Interpersonal skills. Communication skills, cooperation, conflict management, etc. This is important for interaction with students, colleagues and other project participants.
- Analytical and critical thinking. Ability to analyze information, solve problems, make informed decisions and improve learning processes.
- Creativity and innovation. Ability to develop new approaches, methods and solutions to improve the educational process.
- Leadership and organizational skills. Ability to manage a group, organize and plan activities, and coordinate teamwork.
- Self-organization and ability to work in stressful situations. Ability to effectively manage time and perform tasks under pressure and constraints.

Quantitative competence measurement can be caused by the difficulty of considering all aspects and qualities, including incompetence. However, some approaches help quantify competency:

- Assessment based on various indicators. Creating a set of indicators reflecting different aspects of competence and assigning them numerical values. For example, specific points can be awarded for each successfully completed project or task.

- Testing and assessment centers. Development of test tasks or scenarios that allow assessing competence in certain situations. Test results can determine the level of competence.

- Assessment based on achievements. Measuring competence based on specific achievements, such as completed projects, scientific publications, and feedback from students and colleagues.

It is essential to consider that quantitative competence measurement may be limited and may not always accurately reflect all aspects of performers' competence. Therefore, in most cases, combining quantitative and qualitative assessment methods allows for a more complete and objective assessment of the level of competence.

Let's consider the method and model of assessing the level of competences of the performers of educational projects on three levels: the level of knowledge assessment, the level of performance assessment and the assessment of personal characteristics of the performers. Accumulated time series increments assessments of the performer's competences e_i^q at a moment in time t_i $i = \overline{0, w-1}$ by level The knowledge rating is defined as follows :

$$\Delta K^q = \{k_0^q, k_1^q, \dots, k_{w-1}^q\},$$

where ΔK^q is the time a number of accumulated increments assessments of the performer's competences e_i^q at the moment of time t_i , k_i^q , $i = \overline{0, w-1}$ is the value of the series.

Origin and meaning k_0^q are defined as a weighted sum of the following indicators entered into the system by the evaluator :

$$k_0^q = \sum_{j=1}^4 \chi_j k_{j,0}^q,$$

where

$$- k_{1,0}^q = \frac{\bar{u} - \bar{k}_{1,0}^q}{\bar{u}}, \bar{k}_{1,0}^q \leq \bar{u},$$

where $\bar{k}_{1,0}^q$ is the number of certificates in the direction of the project with a confirmed passing score of the performer e^q , which were recorded until the moment of time t_0 , $k_{1,0}^q \in [0,1]$.

Since, $\bar{k}_{1,0}^q > \bar{u}$ then it is assumed that $\bar{k}_{1,0}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the evaluation

frequency for the initial value $u = 1$;

$$- k_{2,0}^q = \frac{\bar{u} - \bar{k}_{2,0}^q}{\bar{u}}, \bar{k}_{2,0}^q \leq \bar{u},$$

where $\bar{k}_{2,0}^q$ is the number of certificates of participation in conferences, seminars of the performer e^q recorded up to the moment of time t_0 , $k_{2,0}^q \in [0,1]$.

If $\bar{k}_{2,0}^q > \bar{u}$, then it is assumed that $\bar{k}_{2,0}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of

evaluation, for the initial value $u = 1$;

- $k_{3,0}^q$ is the presence of a scientific degree and academic title in the direction of the topic of the performer's project e^q until the moment of time t_0 , the distribution of points is carried out according to the scale :

- $k_{3,0}^q = 0.2$ - if performer e^q at the moment t_0 is PhD;
- $k_{3,0}^q = 0.4$ - if performer e^q at the moment t_0 is PhD and associate professor;
- $k_{3,0}^q = 0.6$ - if performer e^q at the moment t_0 is a doctor of sciences and associate professor;
- $k_{3,0}^q = 0.8$, if performer e^q at the moment t_0 is a doctor of sciences and professor;

- $k_{3,0}^q = 1$ - if performer e^q at the moment t_0 is a doctor of sciences, a professor and a member of the Academy of Sciences;

$$- k_{4,0}^q = \frac{k_0^{\max} - \bar{k}_{4,0}^q}{k_0^{\max}},$$

where k_0^{\max} is the maximum rating, which there is a higher education institution according to the QS system at the moment of time, $\bar{k}_{4,0}^q$ the rating of the higher education institution in which the performer works e^q at a moment in time t_0 ;

$$- \chi_j, j = \overline{1,4} \text{ are weight coefficients, } \chi_1 = \frac{3}{6}, \chi_2 = \chi_3 = \chi_4 = \frac{1}{6}.$$

The next period of the value of the assessment of the level of competences is overridden . The redetermination period under this system is 1 month. Overdetermined values can be written using the formula :

$$k_i^q = \sum_{j=1}^4 \chi_j \left(k_{j,0}^q + \sum_{r=1}^i \Delta k_{j,r}^q \right), i = \overline{1, w-1},$$

where

$$- k_{1,0}^q = \frac{\bar{u} - \bar{k}_{1,0}^q}{\bar{u}}, \Delta k_{1,r}^q = \frac{\bar{u} - \bar{k}_{1,r}^q}{\bar{u}}, \bar{k}_{1,r}^q \leq \bar{u},$$

where $\bar{k}_{1,r}^q$ is the number of certificates in the direction of the project with a confirmed passing score of the performer e^q in the time interval $(t_{r-1}, t_r]$, $k_{1,r}^q \in [0,1]$, $k_{1,0}^q$ is the initial assessment.

If $\bar{k}_{1,r}^q > \bar{u}$, then it is assumed that $\bar{k}_{1,r}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the evaluation

frequency, if the evaluation takes place annually, then $u = 1$, quarterly - $u = 4$, monthly - $u = 12$;

$$- k_{2,0}^q = \frac{\bar{u} - \bar{k}_{2,0}^q}{\bar{u}}, \Delta k_{2,r}^q = \frac{\bar{u} - \bar{k}_{2,r}^q}{\bar{u}}, \bar{k}_{2,r}^q \leq \bar{u},$$

where $\bar{k}_{2,r}^q$ is the number of certificates for participation in conferences, seminars of the performer e^q in the period of time $(t_{r-1}, t_r]$, $k_{2,r}^q \in [0,1]$, $k_{2,0}^q$ is initial assessment. If $\bar{k}_{2,r}^q > \bar{u}$, then it is assumed that $\bar{k}_{2,r}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the evaluation frequency, if the evaluation takes place annually, then $u = 1$, quarterly - $u = 4$, monthly - $u = 12$;

– $k_{3,r}^q$ is the presence of a scientific degree and academic title in the direction of the subject of the performer's e^q project in the period of time $(t_{r-1}, t_r]$, the distribution of points is carried out according to a scale: if the performer t_r received a scientific degree or academic title at the moment of time, then $k_{3,r}^q = 0.2$, otherwise $k_{3,r}^q = 0$, $k_{3,0}^q$ is initial assessment;

$$- k_{4,0}^q = \frac{k_0^{\max} - \bar{k}_{4,0}^q}{k_0^{\max}},$$

$$\Delta k_{4,r}^q = \begin{cases} \frac{k_r^{\max} - \bar{k}_{4,r}^q}{k_r^{\max}} - k_{4,0}^q, & \frac{k_r^{\max} - \bar{k}_{4,r}^q}{k_r^{\max}} - k_{4,0}^q \geq 0 \\ 0, & \frac{k_r^{\max} - \bar{k}_{4,r}^q}{k_r^{\max}} - k_{4,0}^q < 0 \end{cases},$$

k_r^{\max} is the maximum rating, which has a QS system in a period of time $(t_{r-1}, t_r]$, $\bar{k}_{4,r}^q$ is the rating of the higher education institution in which the performer works e^q in the time interval $(t_{r-1}, t_r]$, $k_{4,0}^q$ is the initial assessment, the calculation is carried out only if the rating of the higher education institution was updated during the time interval $(t_{r-1}, t_r]$, otherwise $\Delta k_{4,r}^q = 0$;

$$- \chi_j, j = \overline{1,4} \text{ are weight coefficients, } \chi_1 = \frac{3}{6}, \chi_2 = \chi_3 = \chi_4 = \frac{1}{6}.$$

Accumulated time series increments assessments of the performer's competences e_i^q at a moment in time t_i , $i = \overline{0, w-1}$. The productivity rating is determined as follows :

$$\Delta P^q = \{p_0^q, p_1^q, \dots, p_{w-1}^q\},$$

where ΔP^q is the accumulated time series increments assessments of the performer's competences e_i^q at the moment of time t_i .

Initial value p_0^q is defined as a weighted sum of the following indicators entered into the system by the evaluator :

$$p_0^q = \sum_{j=1}^5 \gamma_j p_{j,0}^q,$$

where

$$- p_{1,0}^q = \frac{\bar{u} - \bar{p}_{1,0}^{-q}}{\bar{u}}, \bar{p}_{1,0}^{-q} \leq \bar{u},$$

where $\bar{p}_{1,0}^{-q}$ is the H-index of the performer e^q at the moment of time according to the t_0 Scopus database, $p_{1,0}^q \in [0,1]$, if $\bar{p}_{1,0}^{-q} > \bar{u}$, then it is assumed that $\bar{p}_{1,0}^{-q} = \bar{u}$,

$\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of evaluation, for the initial value $u = 1$;

$$- p_{2,0}^q = \frac{\bar{u} - \bar{p}_{2,0}^{-q}}{\bar{u}}, \bar{p}_{2,0}^{-q} \leq \bar{u},$$

where $\bar{p}_{2,0}^{-q}$ is the number of scientific publications indexed in the Scopus database performer e^q at the moment of time according to the t_0 Scopus database,

$p_{2,0}^q \in [0,1]$, if $\bar{p}_{2,0}^{-q} > \bar{u}$, then it is assumed that $\bar{p}_{2,0}^{-q} = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the

frequency of evaluation, for the initial value $u = 1$;

$$- p_{3,0}^q = \frac{\bar{u} - \bar{p}_{3,0}^{-q}}{\bar{u}}, \bar{p}_{3,0}^{-q} \leq \bar{u},$$

where $\bar{p}_{3,0}^{-q}$ is the number of citations of scientific publications indexed in the Scopus database performer e^q at the moment of time according to the t_0 Scopus

database , $p_{3,0}^q \in [0,1]$, if $\bar{p}_{3,0}^q > \bar{u}$, then it is assumed that $\bar{p}_{3,0}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u

is the frequency of evaluation , for the initial value $u = 1$;

$$- p_{4,0}^q = \frac{\bar{u} - \bar{p}_{4,0}^q}{u}, \bar{p}_{4,0}^q \leq \bar{u},$$

where $\bar{p}_{4,0}^q$ is the number of created educational modules (authorship confirmed on the project website) performer e^q at the moment of time according to the

t_0 Scopus database , $p_{4,0}^q \in [0,1]$, if $\bar{p}_{4,0}^q > \bar{u}$, then it is assumed that $\bar{p}_{4,0}^q = \bar{u}$,

$\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of evaluation , for the initial value $u = 1$;

$$- p_{5,0}^q = \frac{\bar{u} - \bar{p}_{5,0}^q}{u}, \bar{p}_{5,0}^q \leq \bar{u},$$

where $\bar{p}_{5,0}^q$ is e^q at the moment of time according to the t_0 Scopus database ,

$p_{5,0}^q \in [0,1]$, if $\bar{p}_{5,0}^q > \bar{u}$, then it is assumed that $\bar{p}_{5,0}^q = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the

frequency of evaluation , for the initial value $u = 1$;

$$- \gamma_j, j = \overline{1,5} \text{ are weight coefficients, } \gamma_1 = \gamma_3 = \frac{1}{8}, \gamma_2 = \gamma_4 = \gamma_5 = \frac{1}{4}.$$

Redefined and value p_i^q are determined by the formula :

$$p_i^q = \sum_{j=1}^5 \gamma_j \left(p_{j,0}^q + \sum_{r=1}^i \Delta p_{j,r}^q \right), i = \overline{1, w-1},$$

where

$$- p_{1,0}^q = \frac{\bar{u} - \bar{p}_{1,0}^q}{u}, \Delta p_{1,r}^q = \frac{\bar{u} - \bar{p}_{1,r}^q}{u}, \bar{p}_{1,r}^q \leq \bar{u},$$

where $\bar{p}_{1,r}^{-q}$ is the Hirsch index of the performer e^q received in the time interval $(t_{r-1}, t_r]$, $p_{1,r}^q \in [0,1]$, $p_{1,0}^q$ is the initial assessment, if $\bar{p}_{1,r}^{-q} > \bar{u}$, then it is accepted that $\bar{p}_{1,r}^{-q} = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of assessment, if the assessment takes place annually, then $u = 1$, quarterly - $u = 4$, monthly - $u = 12$;

$$- p_{2,0}^q = \frac{\bar{u} - \bar{p}_{2,0}^{-q}}{\bar{u}}, \Delta p_{2,r}^q = \frac{\bar{u} - \bar{p}_{2,r}^{-q}}{\bar{u}}, \bar{p}_{2,r}^{-q} \leq \bar{u},$$

where $\bar{p}_{2,r}^{-q}$ is the number of scientific publications indexed in the Scopus database of the performer e^q received in the time interval $(t_{r-1}, t_r]$, $p_{2,r}^q \in [0,1]$, $p_{2,0}^q$ is the initial assessment, if $\bar{p}_{2,r}^{-q} > \bar{u}$, then it is accepted that $\bar{p}_{2,r}^{-q} = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of assessment, if the assessment takes place annually, then $u = 1$, quarterly - $u = 4$, monthly - $u = 12$;

$$- p_{3,0}^q = \frac{\bar{u} - \bar{p}_{3,0}^{-q}}{\bar{u}}, \Delta p_{3,r}^q = \frac{\bar{u} - \bar{p}_{3,r}^{-q}}{\bar{u}}, \bar{p}_{3,r}^{-q} \leq \bar{u},$$

where $\bar{p}_{3,r}^{-q}$ is the number of citations of scientific publications indexed in the Scopus database of the performer e^q received in the time interval $(t_{r-1}, t_r]$, $p_{3,r}^q \in [0,1]$, $p_{3,0}^q$ is the initial assessment, if $\bar{p}_{3,r}^{-q} > \bar{u}$, then it is accepted that $\bar{p}_{3,r}^{-q} = \bar{u}$, $\bar{u} = \left[\frac{100}{u} \right]$, u is the frequency of assessment, if the assessment takes place annually, then $u = 1$, quarterly - $u = 4$, monthly - $u = 12$;

$$- p_{4,0}^q = \frac{\bar{u} - \bar{p}_{4,0}^{-q}}{\bar{u}}, \Delta p_{4,r}^q = \frac{\bar{u} - \bar{p}_{4,r}^{-q}}{\bar{u}}, \bar{p}_{4,r}^{-q} \leq \bar{u},$$

where $\bar{p}_{4,r}^{-q}$ is the number of created training modules (authorship is confirmed on the project website) of the artist e^q , received in the period of time $(t_{r-1}, t_r]$,

$p_{4,r}^q \in [0,1]$, $p_{4,0}^q$ is the initial assessment, if $\bar{p}_{4,r}^q > \bar{u}$, then it is accepted that

$\bar{p}_{4,r}^q = \bar{u}$, $\bar{u} = \left[\frac{10}{u} \right]$, u is the frequency of assessment, if the assessment takes place

annually, then $u = 1$, quarterly – $u = 4$, monthly – $u = 12$;

$$- p_{5,0}^q = \frac{\bar{u} - \bar{p}_{5,0}^q}{u}, \Delta p_{5,r}^q = \frac{\bar{u} - \bar{p}_{5,r}^q}{u}, \bar{p}_{5,r}^q \leq \bar{u},$$

where $\bar{p}_{5,r}^q$ is the number of projects in which the performer participated e^q ,

received in the time interval $(t_{r-1}, t_r]$, $p_{5,r}^q \in [0,1]$, $p_{5,0}^q$ is the initial assessment, if

$\bar{p}_{5,r}^q > \bar{u}$, then it is accepted that $\bar{p}_{5,r}^q = \bar{u}$, $\bar{u} = \left[\frac{5}{u} \right]$, u is the assessment frequency,

if the assessment takes place annually, then $u = 1$, quarterly – $u = 4$, monthly – $u = 12$;

$$- \gamma_j, j = \overline{1,5} \text{ are weight coefficients, } \gamma_1 = \gamma_3 = \frac{1}{8}, \gamma_2 = \gamma_4 = \gamma_5 = \frac{1}{4}. -$$

Initial value y_0^q is defined as a weighted sum of the following indicators entered into the system by the evaluator :

$$y_0^q = \rho_1 y_{1,0}^q + \rho_2 y_{2,0}^q,$$

where

– $y_{1,0}^q$ - the results modified assessment test personality and executor e^q , normalized on segment $[0,1]$, $y_{1,0}^q \in [0,1]$;

– $y_{2,0}^q$ - the results assessment performer e^q by others performers of the project, normalized for the segment $[0,1]$, $y_{2,0}^q \in [0,1]$;

$$- \rho_j, j = \overline{1,2} \text{ are weight coefficients, } \rho_1 = \frac{2}{3}, \rho_2 = \frac{1}{3}. -$$

The following value y_i^q is defined as a weighted sum of the following indicators entered into the system by the evaluator :

$$y_i^q = \sum_{j=1}^2 \rho_j \left(y_{j,0}^q + \sum_{r=1}^i \Delta y_{j,r}^q \right), \quad i = \overline{1, w-1},$$

$$- \Delta y_{j,r}^q = \begin{cases} y_{j,r}^q - y_{j,r-1}^q, & y_{j,r}^q - y_{j,r-1}^q \geq 0 \\ 0, & y_{j,r}^q - y_{j,r-1}^q < 0 \end{cases},$$

$$\rho_j, \quad j = \overline{1,2} \text{ are weight coefficients, } \rho_1 = \frac{2}{3}, \rho_2 = \frac{1}{3}.$$

Then for the performer e^q the fact that he provides for educational project A at a moment in time t_i may to be determined by the method of linear convolution . Moreover aim the executor and the corresponding the project is value maximization

$$F(e_i^q) \xrightarrow[i=1, w-1]{e^q \in E} \max ,$$

where

$$F(e_i^q) = \alpha \sum_{j=1}^4 \chi_j \left(k_{j,0}^q + \sum_{r=1}^i \Delta k_{j,r}^q \right) + \beta \sum_{j=1}^5 \gamma_j \left(p_{j,0}^q + \sum_{r=1}^i \Delta p_{j,r}^q \right) + \lambda \sum_{j=1}^2 \rho_j \left(y_{j,0}^q + \sum_{r=1}^i \Delta y_{j,r}^q \right),$$

$$\alpha + \beta + \lambda = 1, \quad \alpha, \beta, \lambda \in [0,1].$$

Value $F(e_i^q) \in [0,1]$ and for the performer $e^q \in E$ at every moment of time t_i they can to be represented as a point on the graph . In general, the values will increase, but during the observation period there may be cases when the value stabilizes or decreases. The latter can happen when the executor does not have any results during the implementation of the project and the assessment of his personal qualities has deteriorated compared to the previous period.

To assess the potential of the executor of the educational project in the context of changing his values competences at three levels: knowledge assessment, performance assessment and assessment of personal professional qualities, a couple of points can be fixed :

$$\left\{ (t_i, F(e_i^q)), i = \overline{0, w-1} \right\},$$

where

$$\left\{ \begin{array}{l} a_0(w-1) + a_1 \sum_{i=0}^{w-1} t_i + a_2 \sum_{i=0}^{w-1} t_i^2 + \dots + a_m \sum_{i=0}^{w-1} t_i^m = \sum_{i=0}^{w-1} t_i F(e_i^q) \\ a_0 \sum_{i=0}^{w-1} t_i + a_1 \sum_{i=0}^{w-1} t_i^2 + a_2 \sum_{i=0}^{w-1} t_i^3 + \dots + a_m \sum_{i=0}^{w-1} t_i^{m+1} = \sum_{i=0}^{w-1} t_i^2 F(e_i^q) \\ a_0 \sum_{i=0}^{w-1} t_i^2 + a_1 \sum_{i=0}^{w-1} t_i^3 + a_2 \sum_{i=0}^{w-1} t_i^4 + \dots + a_m \sum_{i=0}^{w-1} t_i^{m+2} = \sum_{i=0}^{w-1} t_i^3 F(e_i^q) \\ \vdots \\ a_0 \sum_{i=0}^{w-1} t_i^m + a_1 \sum_{i=0}^{w-1} t_i^{m+1} + a_2 \sum_{i=0}^{w-1} t_i^{m+2} + \dots + a_m \sum_{i=0}^{w-1} t_i^{2m} = \sum_{i=0}^{w-1} t_i^m F(e_i^q) \end{array} \right. ,$$

Such a system has a unique solution, since the determinant of the system is not equal to zero, that is, the unknowns are determined uniquely a_0, a_1, \dots, a_m . The mean square deviation of the function $f(\cdot)$ from $P_m(t)$ or the error of approximation of the function $f(\cdot)$ by a polynomial $P_m(t)$ is determined by the formula :

$$\delta = \sqrt{\frac{\sum_{i=0}^{w-1} (F(e_i^q) - P_m(t_i))^2}{w}},$$

moreover $\delta \rightarrow 0$ at growth and m .

In case if $m=1$ we obtain the minimization problem in the linear case :

$$S = \sum_{i=0}^{w-1} (F(e_i^q) - a_0 - a_1 t_i)^2 \rightarrow \min ,$$

Here is the estimate of the slope a_1 for the straight line $F(e_i^q) = a_0 + a_1 t_i$ is determined by the formula :

$$a_1 = \frac{\text{cov}(t_i, F(e_i^q))}{\text{var}(t_i)},$$

where

$\text{cov}(t_i, F(e_i^q)) = \frac{1}{w} \sum_{i=0}^{w-1} t_i F(e_i^q) - \frac{1}{w^2} \sum_{i=0}^{w-1} t_i \sum_{i=0}^{w-1} F(e_i^q)$ is the coefficient of covariance,

$\text{var}(t_i)$ is the coefficient of variations .

3.2. The method of forming the competence environment of educational project executors and assessing its potential

Let's consider the definition of the environment of the executor of the educational project. In general, the environment can be both physical and informational. In the context of this work, the information environment, or virtual environment, is considered. A virtual environment is a digital space created with the help of computer technologies, for example, virtual reality and computer simulations. The subject's information environment consists of the subject and its digital activity traces. In the context of this work, traces of activity are scientific publications, educational projects in which the performer participates or participates, the number of educational modules created, etc.

The information competence environment of the educational project executor is a specific environment in which the educational project executor has the opportunity to use information resources effectively, means and technologies to achieve the tasks and goals of the project. This environment promotes the development of the performer's information competencies, providing access to the necessary information, data processing and analysis, the use of tools for communication and collaboration, and the ability to evaluate and critically evaluate information sources. The environment includes the results of the activity of the performance of the educational project, which forms a kind of train of activity indicators, on the basis of which the evaluation of the performer's competencies is evaluated.

The information competence environment helps the executor to effectively process, use and implement the information while working on an educational project, which contributes to the high-quality performance of tasks and the achievement of project goals.

If $E = \{e^1, e^2, \dots, e^m\}$ is the set of executors of the educational project A, then each of them will have their own system of competences and the value they will provide to the project A.

Having a system of competences over a period of time $i = \overline{0, w - 1}$ for each executor of project A, it is possible to standardize the assessment of competences:

$$\overline{K}_i^j = \frac{K_i^j - \min_{j=1,m} K_i^j}{\max_{j=1,m} K_i^j - \min_{j=1,m} K_i^j},$$

$$\overline{P}_i^j = \frac{P_i^j - \min_{j=1,m} P_i^j}{\max_{j=1,m} P_i^j - \min_{j=1,m} P_i^j},$$

$$\overline{I}_i^j = \frac{I_i^j - \min_{j=1,m} I_i^j}{\max_{j=1,m} I_i^j - \min_{j=1,m} I_i^j},$$

and find the average value of the scores of project A performers at each time point $i = \overline{0, w - 1}$:

$$\tilde{K}_i = \frac{1}{m} \sum_{j=1}^m \overline{K}_i^j,$$

$$\tilde{P}_i = \frac{1}{m} \sum_{j=1}^m \overline{P}_i^j,$$

$$\tilde{I}_i = \frac{1}{m} \sum_{j=1}^m \overline{I}_i^j.$$

The average assessment of competences \tilde{A}_i for all performers and criteria at each point in time:

$$\tilde{A}_i = \frac{1}{3} (\tilde{K}_i + \tilde{P}_i + \tilde{I}_i),$$

then we will have w points

$$\{(i + 1, \tilde{A}_i), i = \overline{0, w - 1}\},$$

and the connection between the points is established by the formula:

$$\tilde{A}_i = a + b(i + 1) + \varepsilon_i,$$

hence the problem of minimizing the sum of squared errors arises

$$\sum_{i=0}^{w-1} \varepsilon_i^2 = \sum_{i=0}^{w-1} (\tilde{A}_i - a - b(i+1))^2 \xrightarrow{a,b} \min.$$

Hence, the estimate of the slope \hat{b} for line (2) is determined by the formula:

$$\hat{b} = \frac{\text{cov}(i+1, \tilde{A}_i)}{\text{var}(i+1)},$$

$$\text{де cov}(i+1, \tilde{A}_i) = \frac{1}{w^2} \sum_{i=1}^w \sum_{j=0}^{w-1} \frac{(i-j)}{2} (\tilde{A}_i - \tilde{A}_j),$$

$$\text{var}(i+1) = \frac{1}{r} \sqrt{\frac{1}{w} \sum_{i=0}^{w-1} (i-r)^2},$$

$$r = \frac{1}{w} \sum_{i=1}^w i.$$

Then the assessment of the productivity \tilde{O}_A of the educational project A can be determined by the last recorded assessment of the competencies of the project executors:

$$\tilde{O}_A^1 = \tilde{A}_{w-1} \cdot 100\%. \quad (3.1)$$

The potential of the project, which takes into account the growth of the level of competencies of the project executors during its implementation, is defined as the normalized value of the angular coefficient of the line, which approximates the trend of changes in the indicators of the level of competences of the project executors:

$$\tilde{O}_A^2 = \frac{1}{5} \text{arctg} \hat{b} \cdot 100\%. \quad (3.2)$$

Normalization is calculated by the maximum, based on the numerator of the ratio corresponding to the derivative of the equation of the straight line $\tilde{A}_i = \frac{1}{5}(i+1)$, along the abscissa axis.

If you need to evaluate the productivity and potential of educational projects

$$\{A_1, A_2, \dots, A_r\},$$

for each of which the estimates are calculated according to (3.1), (3.2), that is, calculated $\tilde{O}_{A_k}^1, \tilde{O}_{A_k}^2, k = \overline{1, r}$. An educational project has the greatest productivity if

$$k^1 = \arg \max_{k=1,r} \tilde{O}_{A_k}^1,$$

where k^1 is the number of the educational project with the highest productivity, $k^1 \in [1, r]$.

An educational project has the greatest potential if

$$k^2 = \arg \max_{k=1,r} \tilde{O}_{A_k}^2,$$

where k^2 are the numbers of educational projects that have the greatest potential, $k^2 \in [1, r]$.

Projects whose potentials do not exceed a fixed threshold corresponding to the evaluation system are those whose financing may not be appropriate to continue.

Let's determine the stages of the formation of information environments for the executors of educational projects. The first stage is the calculation of assessments of the components of project executors' competencies, which includes: assessment of the executor's knowledge, assessment of productivity and assessment of personal qualities:

1. Assessment of knowledge of performers: availability of project management certificates, participation in seminars, conferences, etc. The assessment is calculated automatically by the system: the certificates of performers are loaded into the system, based on which the quantitative indicator is calculated. An expert checks the conformity of certificates and documents.

2. Evaluation of the performance of the performer: the number of projects in which the performer participated and their role, the presence of scientific articles within the scope of the subject of the project in the relevant journals, etc. The score is calculated automatically by analyzing portals of scientometric databases and national libraries.

3. Evaluation of personal characteristics: attitude to the performance and timeliness of the performance of specific tasks of the work package, individual features of the performer, sociability, etc. A questionnaire is conducted according to the OPQ system.

The performers' competence level is calculated every six months or every quarter. The updated data is added to the previous ones. In this way, a loop is formed with assessments of the competence levels of performers or a time series that corresponds to the purpose of the educational project in which they participate. Time series of evaluations of performers' competencies are essential for forming the organizational and functional structure of new educational projects, which will include these performers. Depending on the type of educational project, several time series of different lengths can be stored at once in the information environment of the performer. If the performer joins the project, the time series according to the direction of which has already been formed in the information environment of the performer, then the data of this series can be used to evaluate the performer's potential.

Key aspects of work within the framework of educational projects, which can be obtained from the information competence environments of the executors of the educational project:

- Access to information. Providing the executor with the necessary information for the implementation of project tasks. This may include access to scholarly sources, literature, electronic databases, etc.
- Evaluation and selection of information. Development of skills in choosing correct and reliable sources of information, as well as the ability to filter out unimportant or unreliable information.
- Analysis and synthesis. Ability to analyze received information, highlight key aspects, and synthesize knowledge and data.
- Use of technologies. The ability to use various information technologies, programs and tools to organize work with information, its collection, processing and presentation.
- Critical thinking. Development of the ability to critically evaluate information sources, to recognize suspicious or unreliable information, to identify asymmetry of information power.
- Communication and cooperation. Ability to effectively communicate and cooperate with colleagues, experts, students using various means of communication.

- Creation of new information. Ability to generate new ideas, develop research, analysis, articles, educational materials, etc.
- Information protection. Skills in preserving confidentiality, adequate use of data and compliance with copyright rules.

The formed information competence environments of project performers formalize the processes of accumulation of skills and experience of performers, allowing to reflect the transformation of environments, interaction between performers and interaction between the performer and the project. This approach makes it possible to systematically look at the processes of creating and managing educational projects and to ensure the improvement of management efficiency to obtain high project results in dynamic conditions.

3.3. The relationship between the composition of the competence environment of the executors of educational projects and the potential of the projects

The composition of the competence environment of the executors of educational projects is closely related to the potential of these projects. The competence environment determines the ability of executors to realize the potential of projects, ensuring effective development, performance of tasks and achievement of project goals. Here are some ways in which the composition of the competence environment affects the potential of educational projects:

1. Development of professional skills. Competence environment helps executors to develop and deepen their professional skills, which affects the quality of project tasks. The more competencies the executors have, the more opportunities the project has to realize its potential.

2. Innovativeness and creativity. Competence environment promotes the development of innovative approaches and creative solutions. This can improve the quality and results of the project, add uniqueness to it and increase its potential for impact.

3. Effective use of resources. Performers with a high level of competence can

more effectively use available resources, including informational, technical, human and other, which ensures optimal execution of the project.

4. Cooperation and communication. Competent performers can effectively communicate and collaborate with other project team members. This contributes to the improvement of teamwork and the use of synergy of efforts, increasing the project's potential.

5. Adaptation to changes. A high level of competence helps performers adapt to changes in the external environment, deepening knowledge and strengthening skills following new challenges. This allows the project to respond to changing conditions and achieve better results effectively.

6. Optimization of risks. Performers with developed competencies can more deeply analyze and assess the risks associated with the project. This allows you to recognize potential negative scenarios quickly and develop strategies to prevent them or reduce their impact.

In general, the competence environment of the executors of educational projects determines their ability to realize the project's potential, ensuring effective activity, high-quality results and achievement of set goals.

To verify the described method, ten educational projects implemented at Yancheng Polytechnic College from 2014 to 2020 were selected. The duration of the projects is three years. On average, 5 to 8 performers participated in each of the projects. Each executor was analyzed and their competence ratings were calculated during the execution of the projects. For the first component of the performer's competence: assessment of the level of knowledge, it was calculated how many certificates of advanced training courses the performers within the project's scope received graduation diplomas. The productivity rating was also calculated as an objective indicator by counting the number of scientific publications the project executors published within its direction. The number of presentations at conferences on the subject of the project, the number of held workshops and seminars, etc. were also considered. The third indicator of competence: the assessment of the performer's characteristics, was determined by interviewing other project participants working

with this performer, according to the classic occupational personality questionnaire Occupational Personality Questionnaires [19].

All competency assessments were normalized to the interval [0, 1], where 0 is the lowest parameter estimate, and one is the highest. Ratings were fixed every six months, respectively. For each project, six ratings were received for each criterion for each performer. The calculated average values of grades for educational projects (I-X) during their implementation (6 periods), normalized by the maximum on the segment [0, 1], are shown in Fig. 1–10. The first assessment of project productivity (3.1) is the last total assessment for each project. To calculate the second estimate (3.2), the analytical form of the regression lines was found using the method of least squares for each project and the angular coefficients of the lines were calculated. The results were compared with the evaluation of each project, which was issued after its completion based on the results of the final evaluation in percentages (Table 1) according to the scale:

- 1. A – 90–100 %
- 2. B – 80–89 %
- 3. C – 70–79 %
- 4. D – 60–69 %
- 5. F – 0–59 %.

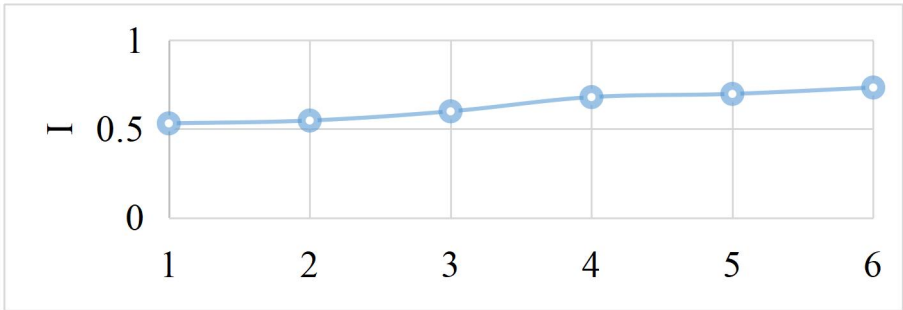


Figure 3.1. - Average values of project I project executors' competency assessments

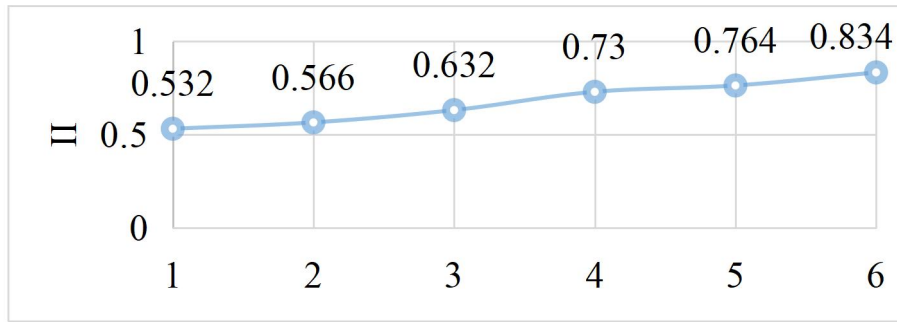


Figure 3.2. - Average values of project II project executors' competency assessments

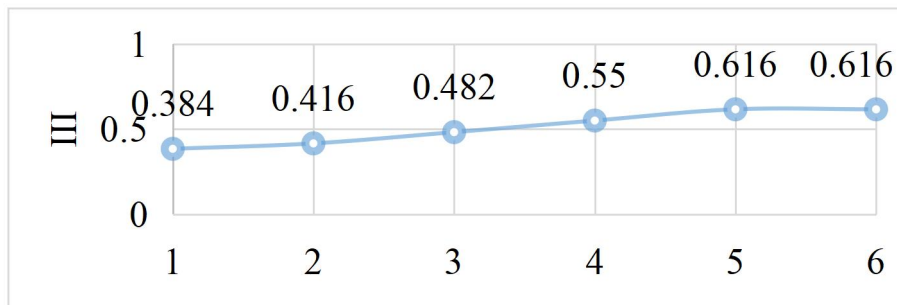


Figure 3.3. - Average values of project III project executors' competency assessments

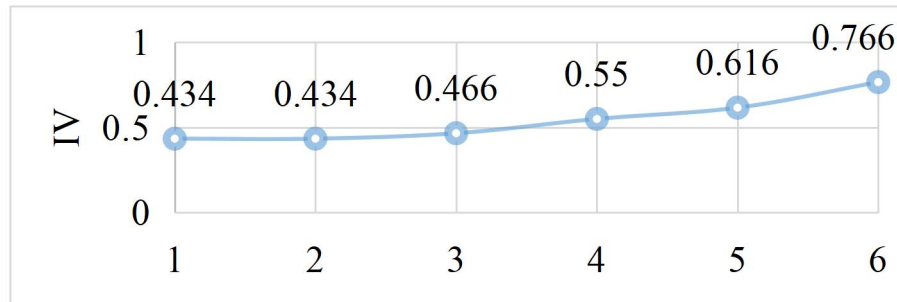


Figure 3.4. - Average values of project IV project executors' competency assessments

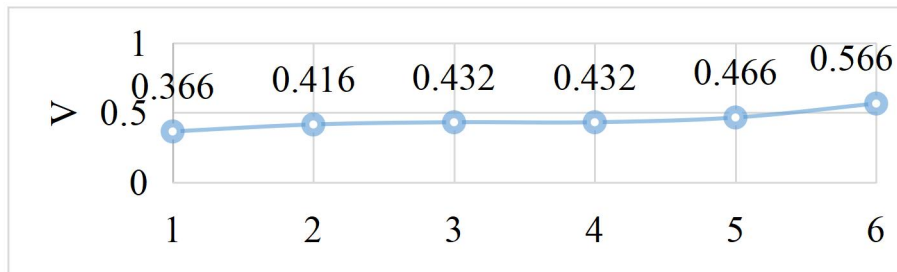


Figure 3.5. - Average values of project V project executors' competency assessments

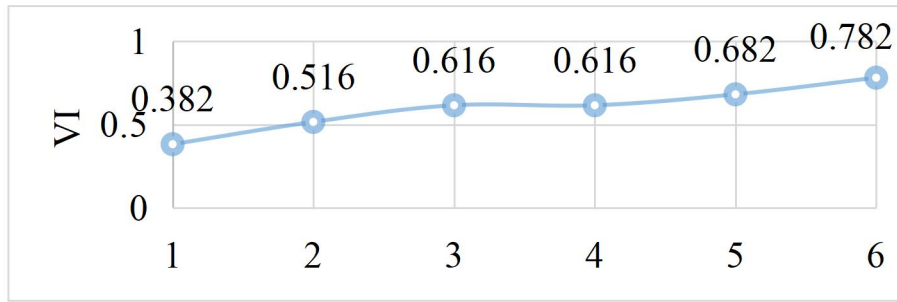


Figure 3.6. - Average values of project VI project executors' competency assessments

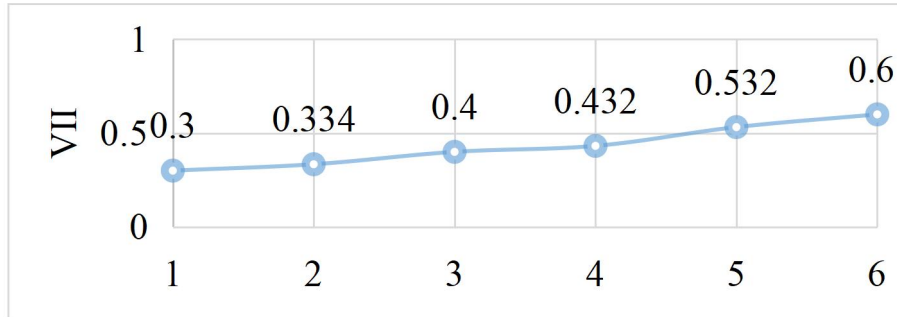


Figure 3.7. - Average values of project VII project executors' competency assessments

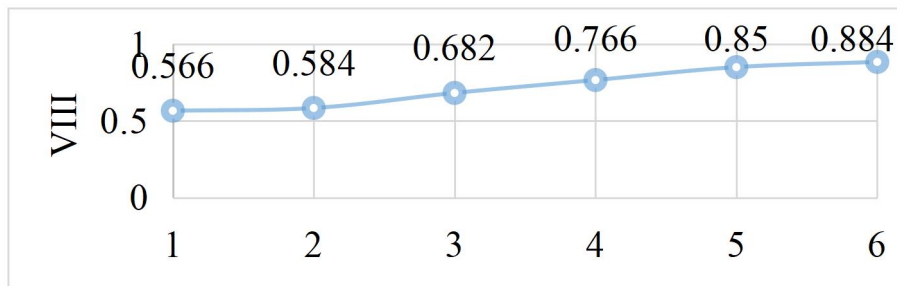


Figure 3.8. - Average values of project VIII project executors' competency assessments

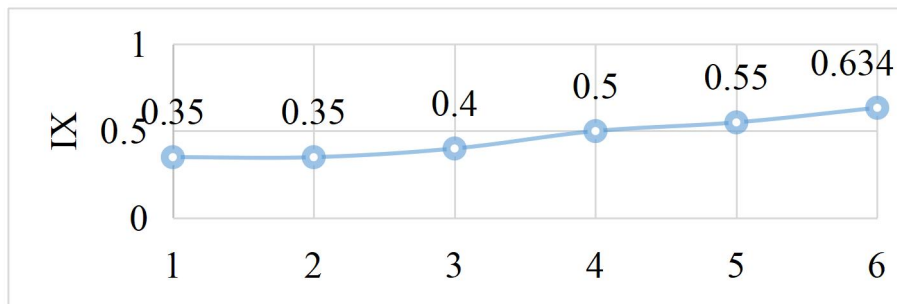


Figure 3.9. - Average values of project IX project executors' competency assessments

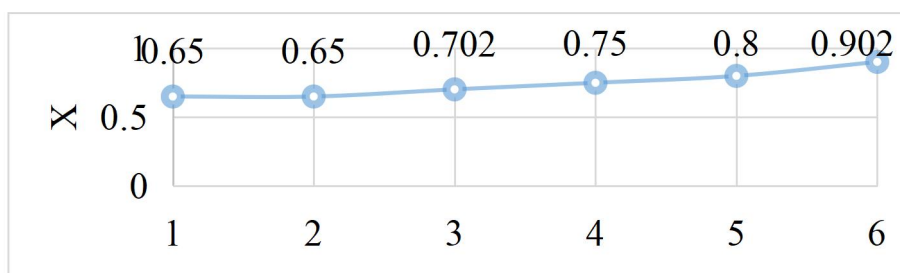


Figure 3.10. - Average values of project X project executors' competency assessments

Table 3.1

Comparison of evaluations of educational projects based on the results of the final evaluation and evaluations of the competencies of performers, calculated according to (3.1), (3.2). Projects that received a score above 60% are highlighted in bold

No. educ. proj.	\tilde{O}_A^1 , (3) and rank $R(\tilde{O}_A^1)$		\tilde{O}_A^2 , (4) and rank $R(\tilde{O}_A^2)$		Final grade O and rank R		$ R - R(\tilde{O}_A^1) $	$ R - R(\tilde{O}_A^2) $
	value (%)	rank	value (%)	rank	value (%)	rank		
I	73,4	6	22,0	9	67	4	2	5
II	83,4	3	31,5	4	73	3	0	1
III	61,6	8	26,1	7	55	7	1	0
IV	76,6	5	32,7	3	60	6	1	3
V	56,6	10	16,4	10	47	10	0	0
VI	78,2	4	35,7	1	65	5	1	4
VII	60,0	9	30,4	5	48	9	0	4
VIII	88,4	2	35,3	2	78	2	0	0
IX	63,4	7	30,3	6	51	8	1	2
X	90,2	1	25,1	8	79	1	0	7

The verification results indicate that the assessment of project executors' competencies recorded at the end of the project almost entirely coincides with the

evaluators' assessment after the project's end (Table 3.1).

However, the assessment, which considers the trend of increasing the level of competencies of the project participants, differs significantly from the evaluators' assessments, although there is a coincidence in some positions. This indicates that the project evaluation is mainly focused on each performer's weight, reputation, and productivity accumulated over time. However, the rate of development of each performer personally in a specific project, his transformation, which enriches the project with relevant values, could have been better taken into account by the evaluators.

The developed multiple models of identification of the executor of the educational project make it possible to present it using a set of identifiers. This makes it possible to consider the dynamics of the components of the information environment when determining the productivity of the educational project (3.1) and its potential (3.2).

This section describes the method that defines the stages of building information environments for educational project implementers in a dynamic environment. The results of applying the method of building information environments are shown in Fig. 3.1–3.10. The result of verification of the method for educational projects at Yancheng Polytechnic College (Table 3.1) showed that the evaluation of the competencies of the project executors obtained by the proposed method correlates with the evaluation of the evaluators after the completion of the project with a coefficient of 0.97.

The advantage of the proposed method is that the evaluation of project executors' competencies is considered dynamically, in contrast to work [8], where these evaluations are considered static as each performer develops with the development of the project. This reveals the possibilities of researching the tendency of the growth of the level of competence of the executors during the implementation of the project, taking into account all the components of competence. It also allows for the analysis of the potential and productivity of the educational project, taking into account the change in the level of competence of the performers. The

development of a multiple model of the identification of the executor of the educational project in a dynamic environment and the selection of critical stages of the construction of its information environment made it possible to quantitatively identify trends in the level of competencies of the project's executors. This completely solves the problem of taking into account the dynamics of the transformation of performers and their connection with the goals of a specific project in the context of building information environments of project performers. The result corresponds to the work [7], in which it is indicated that the values of the level of competence of the performers directly influence the effectiveness of the projects as a whole.

The limitation of the study is that to calculate the quantitative assessments of the components of competencies, it is necessary to assess the level of knowledge, calculate the number of certificates, and conduct testing with a specific frequency. To evaluate productivity, if productivity is determined by publication activity, it is necessary to collect data from international scientometric databases Scopus, WoS, in the profiles of Orcid, Publons, etc. Citation data is presented in scientometric databases and communities of academic publishers CrossReff, etc.

To assess personal qualities, it is necessary to conduct a questionnaire according to the OPQ system or in another way. Without automation of this process, this approach to evaluation is cumbersome. In this study, an information system was developed that allows you to automatically collect data on the first two components of competencies, recording the result in the profile of the performers of educational projects. For the third component, performers are periodically (once every six months) offered to pass a test that supplements the assessment of the competence of each project performer, holistically taking into account all its components.

The constructed method of identifying the information environments of the performers of educational projects in a dynamic environment opens up opportunities for a comprehensive study of the connection between the level of competencies of the performers and their changes in dynamics with the project's productivity.

3.4. A decision support model based on the results of monitoring educational projects based on the dynamics of informational competence environments

Knowing the system for calculating the potential and productivity of an educational project, it is essential to develop a decision-support model based on project monitoring results. At the same time, the dynamics of information competence environments should be considered. Operational decisions should concern the status of the executors of educational projects. After all, as already indicated, the competencies of the executors of educational projects shape the assessment of the entire project, which affects the quality of its implementation.

From Figure 3.1. - 3.10 shows that, in general, the average values of the evaluations of the competencies of the executors of educational projects increase during the implementation of the projects. This is mainly explained by the fact that within the framework of the project, the performers must publish scientific works related to the topic, participate in conferences and seminars, and undergo certification. Accordingly, the level of competencies will increase. However, there are cases when the competencies of some performers need to have a positive tendency toward growth. To do this, it is necessary to divide the executors of the educational project into several categories. Moreover, these categories can change for different performers in project implementation.

In table 3.2. indicators of the competences of the executors of educational projects are given. In table 3.3. the possible operational goals of the decision-maker, i.e. the project manager, are given.

As can be seen from Table 3.3. category W0 means that the performer is unnecessary for the project. The value it brings to the project is practically zero. Accordingly, it should be removed from the project. Category W1 means that the performer has the highest level of competence and brings the most value to the project. His work should be appropriately motivated by the project manager or the person who makes the decision.

Table 3.2.

Indicators of the level of competencies of the executors of educational projects

Identifier	Criteria
Evaluation of the performer's knowledge	
K1	the number of certificates in the direction of the project with a confirmed passing score of the performer
K2	the number of certificates of participation in conferences, seminars of the performer
K3	the presence of a scientific degree and academic title in the direction of the topic of the performer's project
K4	the highest ranking that a university has according to the QS system
Evaluation of the performer's productivity	
P1	H-index
P2	the number of scientific publications indexed in the performer's Scopus database
P3	the number of citations of scientific publications indexed in the performer's Scopus database
P4	the number of educational modules created (authorship confirmed on the project website) by the performer
P5	the number of projects in which the performer participated
Assessment of the performer's personal qualities	
Y1	the results of the modified test of the personality of the performer
Y2	the results of the evaluation of the performer by other performers of the project

Table 3.3.

Operational objectives of the decision maker

Identifier	Operational goals
W0	The executor is removed from the project, because the competences of the executor are not sufficient to participate in the project
W1	The executor belongs to the first category, the competence of the executor is at a high level to participate in the project
W2	The executor belongs to the second category, the competence of the executor at the average level for participation in the project
W3	The executor belongs to the third category, the competence of the executor is at a sufficient level to participate in the project
W4	The executor belongs to the fourth category, the competence of the executor is at a low level for participation in the project
W5	The executor belongs to the fifth category, the competence of the executor is at a very low level for participation in the project. If the trend continues, it may be assigned a W0 identifier

Category W2 means that the performer's competence is at an average level, he is valuable for the project. In categories W3, W4, W5, there is a gradual decrease in performers' competence levels. In the last category W5, this level is critically low. Accordingly, both the executor and the manager should monitor the change in the

estimate in the future. It is fashionable to use asymptotic theory to establish W identifiers and potential operational goals for the project manager. Let the evaluations of the potentials of the executors of the educational project be determined in the context of changes in their evaluations of competencies at three levels: evaluation of knowledge, evaluation of productivity and evaluation of personal professional qualities:

$$\{(t_i, F(e_i^q)), i = \overline{0, w-1}\},$$

where $F(e_i^q) = f(t_i)$, $f(\cdot)$ is a function that reflects the change in the value that the executor assigns to project A at points in time t_i , $i = \overline{0, w-1}$,

$F(e_0^q), F(e_1^q), \dots, F(e_{w-1}^q)$ is the value of the function $f(\cdot)$ in points

$$t_0, t_1, \dots, t_{w-1}.$$

Moment of time t_{w-1} is the moment in time when the project manager makes a decision. Value of functions $F(e_i^q) = f(t_i)$ defined from the segment $[0,1]$. Let there be some ideal performer, for whom we will put the maximum performance results in points t_0, t_1, \dots, t_{w-1} . Then we get the following function $F^{\max}(t_i)$, which will rise sharply and set a level that is ideal for any performer (upper asymptote). In real conditions, it is almost impossible to reach such a level. Similarly, it can be assumed that there is an inefficient executor who has minimal productivity values during the execution of the project. That is, we will get an estimate $F^{\min}(t_i)$ (lower asymptote).

The real values of the estimates of the performance of performers will be somewhere in the middle between the lower and upper asymptotes. Based on this, you can determine the category of each artist. Moreover, we will rely not on the minimum and maximum value, but on the simulated values of the ratings of a potential ideal and inefficient performer.

In order to show the manager's decision-making scheme, let's take project X as an example. This project was implemented in Yancheng Polytechnic College for the period from 2014 to 2020. The duration of the project is 3 years. 8 performers

participated in this project. In Figure 3.10. the average values of the evaluations of project executors' competencies are indicated. Let's consider in more detail what the performance values of project executors were during the implementation of the project. In table 3.4. the value of the competencies of the eight performers of the X project is shown.

Table 3.4.

The value of the competencies of project X performers

Ex. Per.	1	2	3	4	5	6	7	8
1	0,560	0,660	0,670	0,680	0,760	0,770	0,590	0,510
2	0,567	0,670	0,670	0,680	0,790	0,719	0,590	0,510
3	0,578	0,690	0,688	0,756	0,871	0,879	0,630	0,520
4	0,579	0,708	0,732	0,766	0,913	0,945	0,670	0,690
5	0,603	0,722	0,789	0,834	0,917	0,967	0,780	0,790
6	0,656	0,855	0,912	0,948	0,967	0,988	0,904	0,987

In Figure 3.11. the evaluation of the level of competences of all project executors is shown. It can be seen from the figure that performer number 1 lags behind the others. The upper and lower asymptotes were constructed (Figure 3.12) and the categories of performers were calculated:

1. Category W0 includes performers whose average level of competence is in the

$$\text{interval} \left[0, \frac{F^{\max}(t_{w-1}) + F^{\min}(t_{w-1})}{2} \right].$$

For project X, this interval is defined as follows:

$$\left[0, \frac{0.995 + 0.300}{2} \right] = [0, 0.6475]$$

2. To other categories W_j , $j = \overline{1,5}$ belong to those performers whose average level of competence is determined from the interval:

$$W1: \left[\frac{F^{\max}(t_{w-1}) + F^{\min}(t_{w-1})}{2}, \frac{6F^{\max}(t_{w-1}) + 4F^{\min}(t_{w-1})}{10} \right];$$

$$W2: \left[\frac{6F^{\max}(t_{w-1}) + 4F^{\min}(t_{w-1})}{10}, \frac{7F^{\max}(t_{w-1}) + 3F^{\min}(t_{w-1})}{10} \right];$$

$$W3: \left[\frac{7F^{\max}(t_{w-1}) + 3F^{\min}(t_{w-1})}{10}, \frac{8F^{\max}(t_{w-1}) + 2F^{\min}(t_{w-1})}{10} \right];$$

$$W4: \left[\frac{8F^{\max}(t_{w-1}) + 2F^{\min}(t_{w-1})}{10}, \frac{9F^{\max}(t_{w-1}) + F^{\min}(t_{w-1})}{10} \right];$$

$$W5: \left[\frac{9F^{\max}(t_{w-1}) + F^{\min}(t_{w-1})}{10}, F^{\max}(t_{w-1}) \right].$$

The performer belongs to the category, if his average level of competences belongs to the interval:

$$\left[\frac{(5+j-1) \cdot F^{\max}(t_{w-1}) + (5-j+1) \cdot F^{\min}(t_{w-1})}{10}, \frac{(5+j) \cdot F^{\max}(t_{w-1}) + (5-j) \cdot F^{\min}(t_{w-1})}{10} \right]$$

To see what influence the average level of competences of the performers has on the overall assessment of the project. There were decisions in period 4 to make an operational decision and remove from the project the performer with number 1 with the lowest assessment of competences (in table 3.4. they are highlighted in italics).

As a result, there was an increase in the overall estimate of the project (Figure 3.13, 3.14) in the 6th period by 3.74%. The obtained estimate of the project in the 6th period is equal to 0.937. After the operative decision was made, the evaluations of the

competences of other performers in the last two periods practically did not change. Some of the change is due to the fact that the removed executor was involved in joint tasks, writing joint articles, conference theses materials during the implementation of the project. This led to a change in plans for the implementation of tasks under this project. In general, the general result confirms the need to divide the project executors into categories to assess their impact on the outcome of the educational project and make operational decisions.

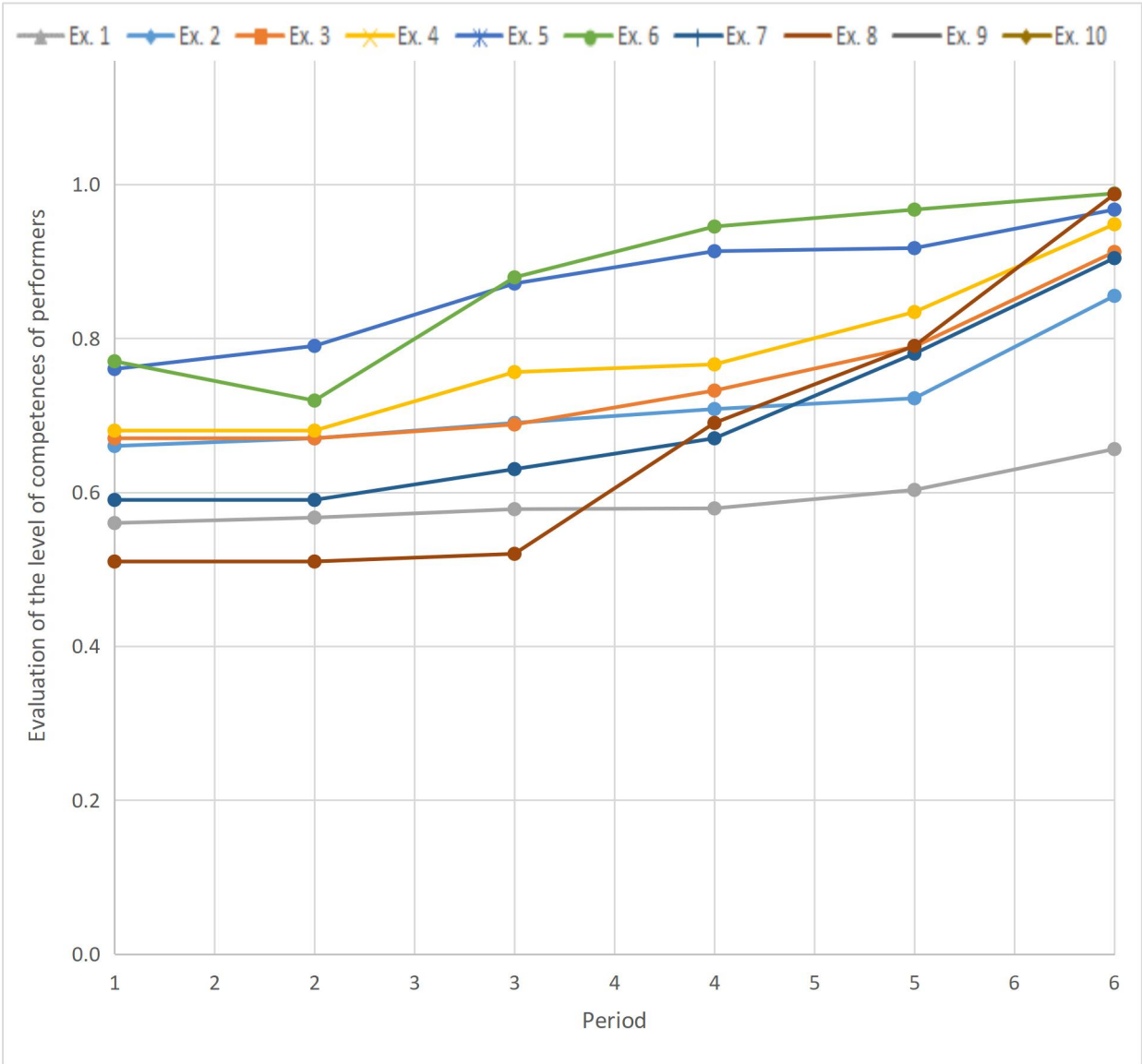


Figure 3.11 - Evaluation of the level of competences of all project executors

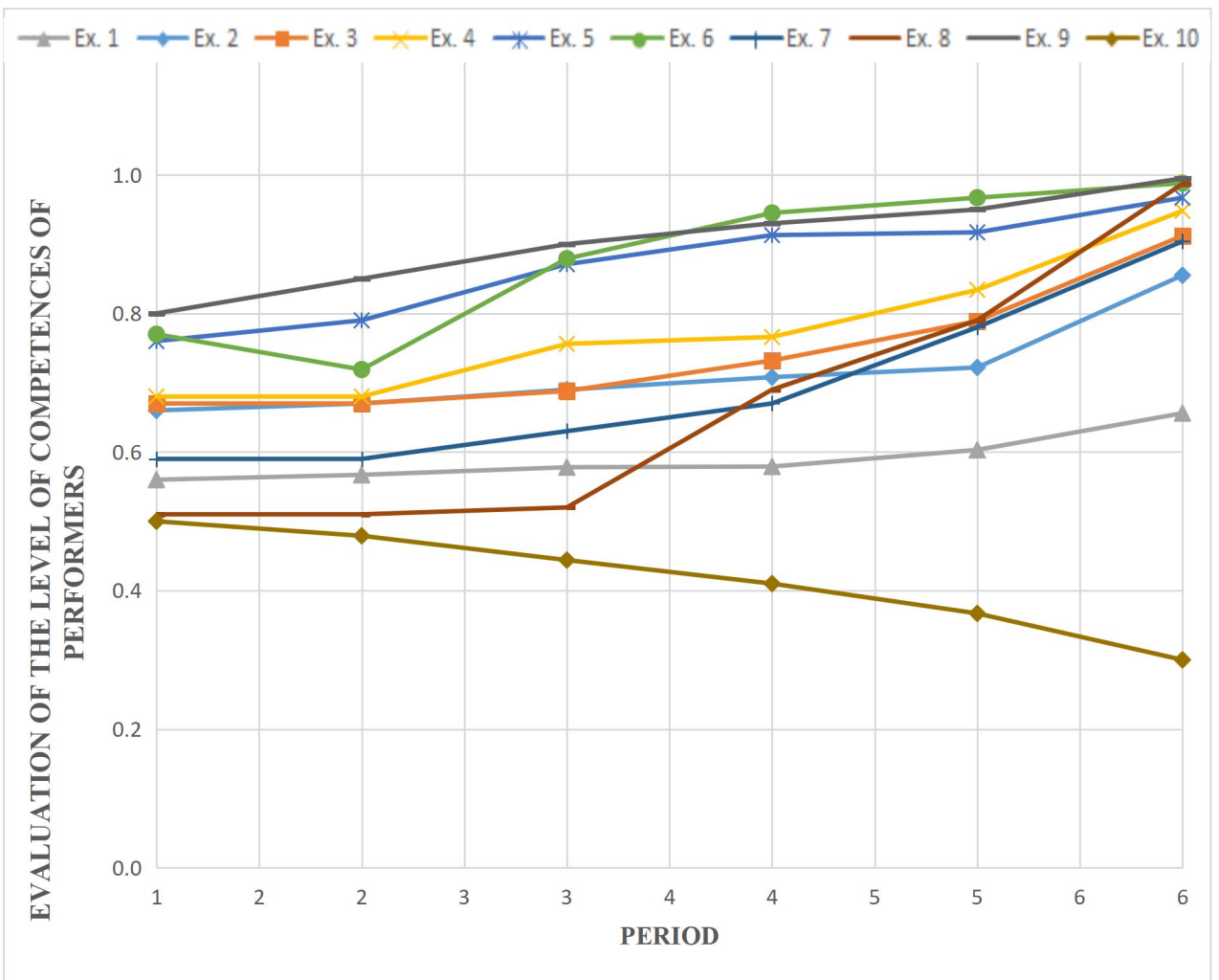


Figure 3.12 - Assessment of the level of competencies of all project executors and asymptotes

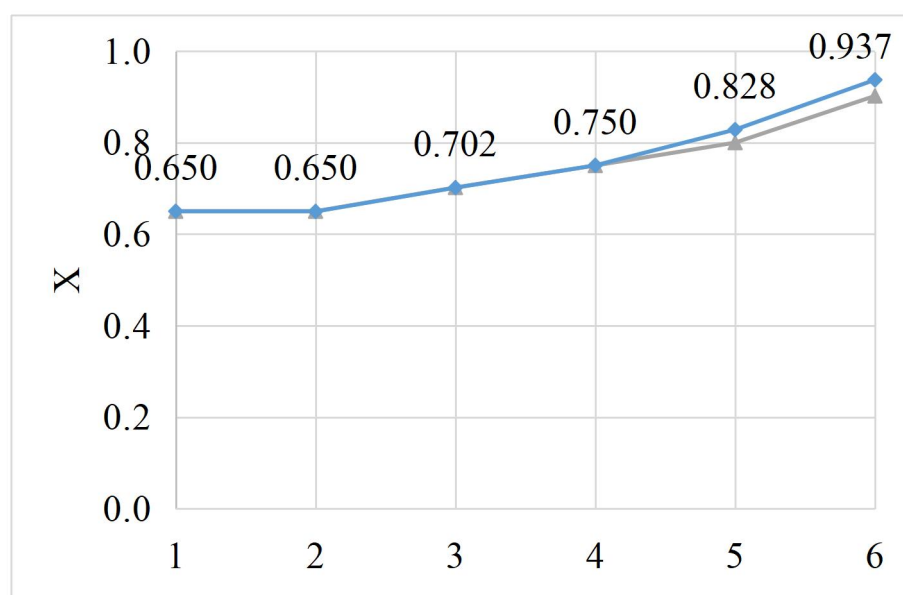


Figure 3.13. Evaluation of the project before the operative decision and after

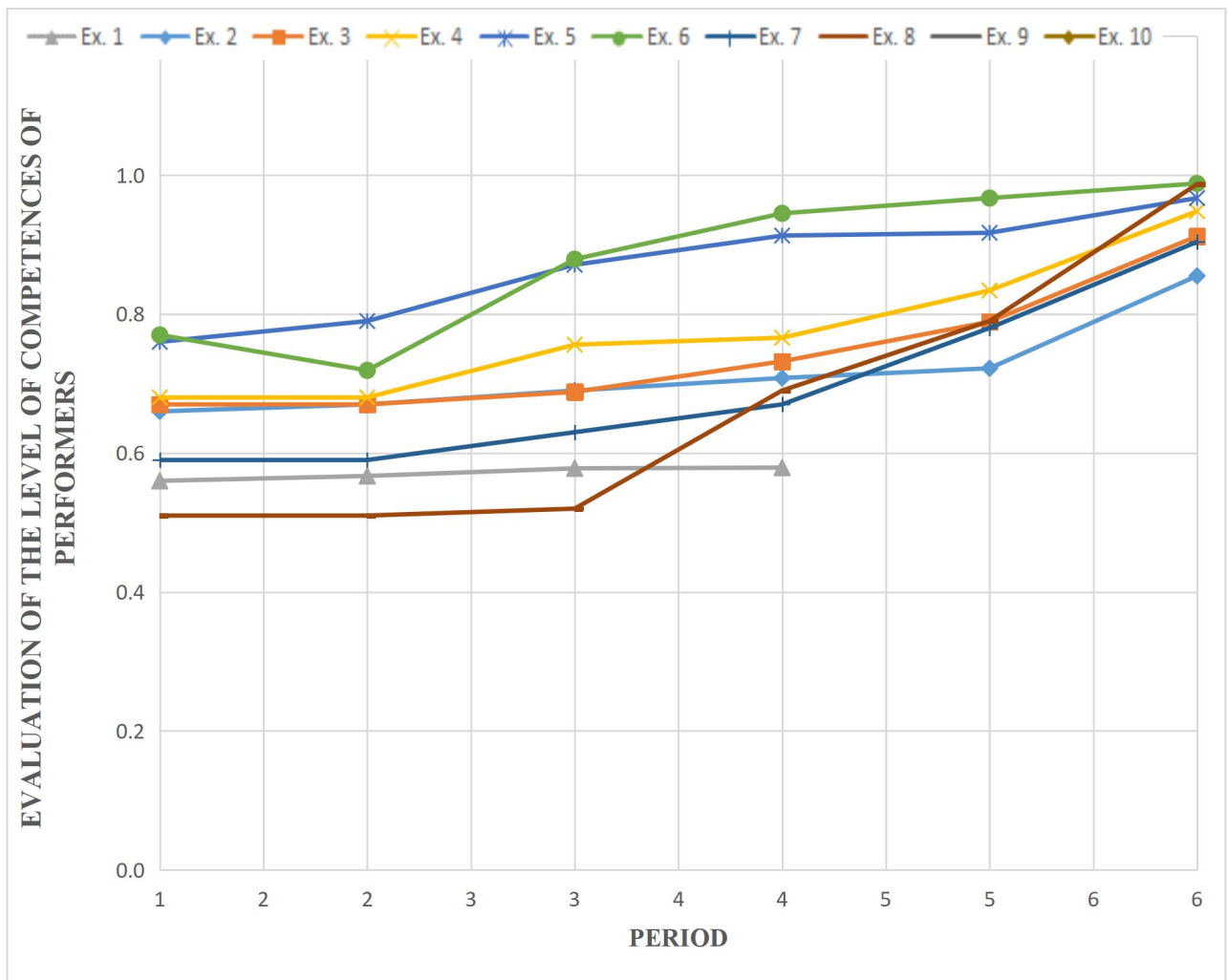


Figure 3.14. Assessment of the level of competences of all project executors after making an operational decision.

As of period 4, it was calculated that the performer with number 1 belonged to the category W0, that is why the operational decision was made to remove him, three performers belonged to the category W1, two - to the category W2, one - to the category W4, and one - to the category W5.

In period 6, it was found that out of seven performers, one belonged to the W3 category, two to the W4 category, and four to the W5 category. Attention should be paid to the limitations that may arise as a result of using the approach. In order to establish an adequate evaluation of the category of performers, sufficient statistical data on the performance of performers must be collected, that is, it is empirically

determined that at least 2 years of observations must pass to obtain results regarding the assessment of competencies and decision-making.

Conclusions to chapter 3

1. The section describes the developed method of forming informational competence environments for the executors of educational projects, which is based on quantitative indicators of their productivity and provides the necessary level of formalization for the application of methods and models for assessing the level of competencies following the requirements of the educational project. The relationship between the composition of the competence environment of the executors of educational projects and the potential of the projects is shown
2. The developed methods of monitoring educational projects based on the dynamics of their information competence environment are described, which are based on open data of performers and can be used in the process of planning and managing an educational project at each stage of its implementation;
3. The further development of decision-making support models for monitoring educational projects based on the dynamics of informational competence environments and models of identification of executors of educational projects was obtained, which expands the theoretical and practical possibilities of ensuring the effectiveness of the implementation, planning and management of educational projects. Indicators of the competencies of the executors of educational projects are described. The possible operational goals of the person who makes the decision, the project manager, are given. Based on an actual project implemented in Yancheng Polytechnic College from 2014 to 2020, an operational solution proposed based on calculations showed a 3.74% increase in overall project evaluation. This percentage was obtained by constructing asymptotes corresponding to the ideal performer (upper asymptote) and the worst performer (lower asymptote).

CHAPTER 4. INFORMATION TECHNOLOGY FOR SUPPORTING DECISION-MAKING FOR MONITORING THE LEVEL OF COMPETENCIES OF PERFORMERS OF EDUCATIONAL PROJECTS

4.1. Determining the goals of building information technology to support decision-making for monitoring the level of competencies, collecting and processing data

Information technology for decision support is a system or set of tools that help collect, analyze and interpret information to make better decisions. The best decisions are those in management that allow you to get financial, resource, time and other effects in the organization's work. This technology combines methods, models, and software tools to process and analyze data, allowing users to identify trends, find solutions, evaluate them, and make better choices.

The information technology of decision-making support for monitoring the level of competencies of the executors of educational projects is understood as a complex of methods, models and means of data collection and processing, which increases the efficiency of management and the effectiveness of educational projects. The effectiveness of educational project management is determined by making personnel, resource, and financial decisions strategically and promptly to achieve the planned results of the project. Performance, as a rule, is determined by a set of KPI indicators, the achievement of which is mandatory. Since the effectiveness of an educational project directly depends on its executors, the executors' competence level is essential for achieving a better result. In addition, it is necessary to understand that the level of competence of the executors of educational projects changes significantly during the project's implementation if the project is extended.

The construction of decision-making support information technology for monitoring the level of competencies of educational project executors consists of the following stages:

1. Analysis of the need for the construction of information technology for monitoring the level of competencies of the executors of educational projects. This stage involves studying the users' needs and defining the goals to be achieved. These goals should be formulated so that the construction of information technology for decision support helps solve them. It is essential to understand what problems need to be solved, what information needs to be collected and what functions the system needs to perform.

2. Collection and processing of data are required to construct information technology to support decision-making. At this stage, information is collected from various sources. To monitor the level of competences, it is fashionable to use information from open sources: databases of scientometric indicators, Hirsch indices from the Scopus database, Web of Science, and Google Scholar. It is also fashionable to use surveys of other project executors regarding the level of competence of other executors to summarize the results of their certification in the direction necessary for the project, etc. This data must then be processed, including structuring, filtering, sorting, and other operations to prepare for analysis.

3. Data analysis for decision support information technology. At this stage, various methods and models are used for data analysis. These can be statistical methods, machine learning algorithms, artificial neural networks and other data analysis tools. The goal is to identify useful information, identify dependencies and regularities, and highlight key factors and decision options.

4. Data visualization. At this stage, the information obtained from data analysis is displayed in an easy-to-understand form, for example, in graphs, charts, maps or other visual elements. This allows users to perceive and understand complex information and established dependencies quickly.

5. Modeling and simulation: Information technology for decision support can include modeling and simulating different scenarios to assess the consequences of different decision options. This allows you to analyze risks, predict outcomes and make more informed choices.

6. Support the decision-making process. Decision support information technology can provide various tools to support the decision-making process, such as spreadsheets, project management systems, etc. This contributes to the structuring of work processes, the automation of some tasks, and the facilitation of communication between process participants.

Of course, for the created information technology to support decision-making for monitoring the level of competencies of the executors of educational projects, these stages can be changed to the needs of users and the goals of creating the technology. Also, each of the stages can be detailed in different ways.

Let's consider the first two stages according to the proposed information technology construction scheme. As already mentioned, the competence of performers is considered in three dimensions:

1. Assessment of knowledge of performers: availability of certificates in the project's direction, certificates regarding participation in conferences, etc. The assessment is calculated automatically by the system: the certificates of performers are loaded into the system, based on which the quantitative indicator is calculated. An expert checks the conformity of certificates and documents.

2. Evaluation of the performance of the performer: the number of projects in which the performer participated and their role, the presence of scientific articles within the scope of the subject of the project in the relevant journals, etc. The score is calculated automatically by analyzing portals of scientometric databases and national libraries.

3. Evaluation of personal characteristics: attitude to the performance and timeliness of the performance of specific tasks of the work package, individual features of the performer, sociability, etc. A survey is being conducted.

The first stage of building information technology is the analysis of needs and goals for building technology. Information technology is universal for complex projects. Therefore, first of all, it is necessary to research educational projects and establish their requirements for the competencies of executors to implement various work packages. The general method of assessing the level of competencies, proposed

in section 3, includes the levels of assessment of the competencies of performers, each of which can be determined by the project's requirements. Table 4.1. a list of such indicators is shown.

Table 4.1.

Levels of assessment of the competences of the executors of educational projects

Competency assessment levels	Indexes
Evaluation of the performer's knowledge	The number of certificates in the direction of the project
	Number of certificates for participation in conferences, seminars
	Availability of a scientific degree and academic title in the direction of the project topic
	The maximum rating that a university has according to the QS system
Performance assessment of the performer	Hirsch index of the executor
	The number of scientific publications indexed in the Scopus database
	Number of citations of scientific publications indexed in Scopus
	Number of educational modules created
	The number of projects in which the executor participated
Assessment of the performer's personal qualities	Results of the modified test of the personality of the executor
	Results of evaluation of the performer by other executors of the project

The construction of information technology will increase the effectiveness of educational projects. The result of the use of information technology for monitoring the level of competencies of the executors of educational projects is the high-quality formation of work teams for the implementation of the project and individual work packages of the project, as well as the constant monitoring of the level of competences of the executors during the project. This will allow tracking of each performer's development in the project implementation process and his contribution to the overall result. Moreover, the monitoring results allow for establishing an increase in the level of competencies of the executors due to their performance of project tasks and the influence of executors with appropriate competencies on the project results. The regularity is clear, the faster the level of competence of project executors increases, the more significant results these executors can provide for the effectiveness of this project as a whole.

A separate issue is the issue of data collection to establish the levels of performers' competencies. An essential criterion for data selection is its reliability. Data must be freely available on the official websites of universities or be documented. Different types of data can be selected to form competency levels. But if you focus on the data shown in Figure 4.1, then the knowledge assessment consists of the following indicators:

- the number of certificates in the project's direction (determined and documented personally. Certificates about the level of knowledge are rarely posted for free use because they are personal. Therefore, to reflect this indicator in the estimate, the performer directly uploads his certificates for a certain period to the system;

- the number of certificates for participation in seminars and conferences determines the level of knowledge of the performer, because he is invited as an expert or speaker. In this case, the performer also uploads his certificates to the system.

- having a scientific degree and a scientific title in the direction of the project topic. To confirm this position, the performer uploads his diplomas to the system.

- the maximum rating that the university has according to the QS system. This indicator is special in this set and does not directly depend on the level of knowledge of the performer. However, it can be assumed that higher-rated universities employ more qualified teachers with higher proficiency levels. That is why this indicator is attached to this level. The determination of this indicator takes place after the annual update of the QS World University Rankings. The indicator is determined by the place of the university with which the performer is affiliated in this rating system.

To establish the performer's productivity level, a number of the following indicators were selected:

- the Hirsch index of the performer according to the Scopus system. The Hirsch index could better estimate a scientist's productivity because, outside the core of the calculation, it loses part of the information about the author's citations. However, it is currently considered a generally accepted method of determining scientific productivity. To determine this indicator, the performer must provide a profile ID in Scopus. The numerical value of the performer's Hirsch index is indicated in the profile. Figure 4.1. the profile of some authors in Scopus is shown and the Hirsch indicator is highlighted, which is read from the page and added to the author's indicators;

- the number of scientific publications indexed in the Scopus database. The number of scientific publications is determined in the Scopus database. Data from the page is transferred to the database to calculate the performer's performance rating. In figure 4.1. the profile of the author is indicated and the number of scientific publications that are in the Scopus database is highlighted;

- the number of citations of scientific publications indexed in Scopus. This indicator is also determined based on the Scopus scientometric database. The information is freely available and available on the author's page (Fig. 4.1). To determine this indicator, the performer must provide a profile ID in Scopus.

- number of educational modules created. This indicator is determined by the executor and is confirmed on the website of the projects within which the training modules were created. Modules that are not presented in the network are not counted;

- the number of projects the performer participated in is determined by the author with confirmation of the information on the project website. Only those projects that are directly related to this educational project are included in this indicator. Suppose the executor participated in a project that is not thematically related to the given project for which monitoring is implemented. In that case, participation in such a project is not counted. Whether the project for which monitoring is implemented corresponds to the project specified by the executor is determined by the person who makes the decision. Keywords and topics of each of the projects are taken into account here.

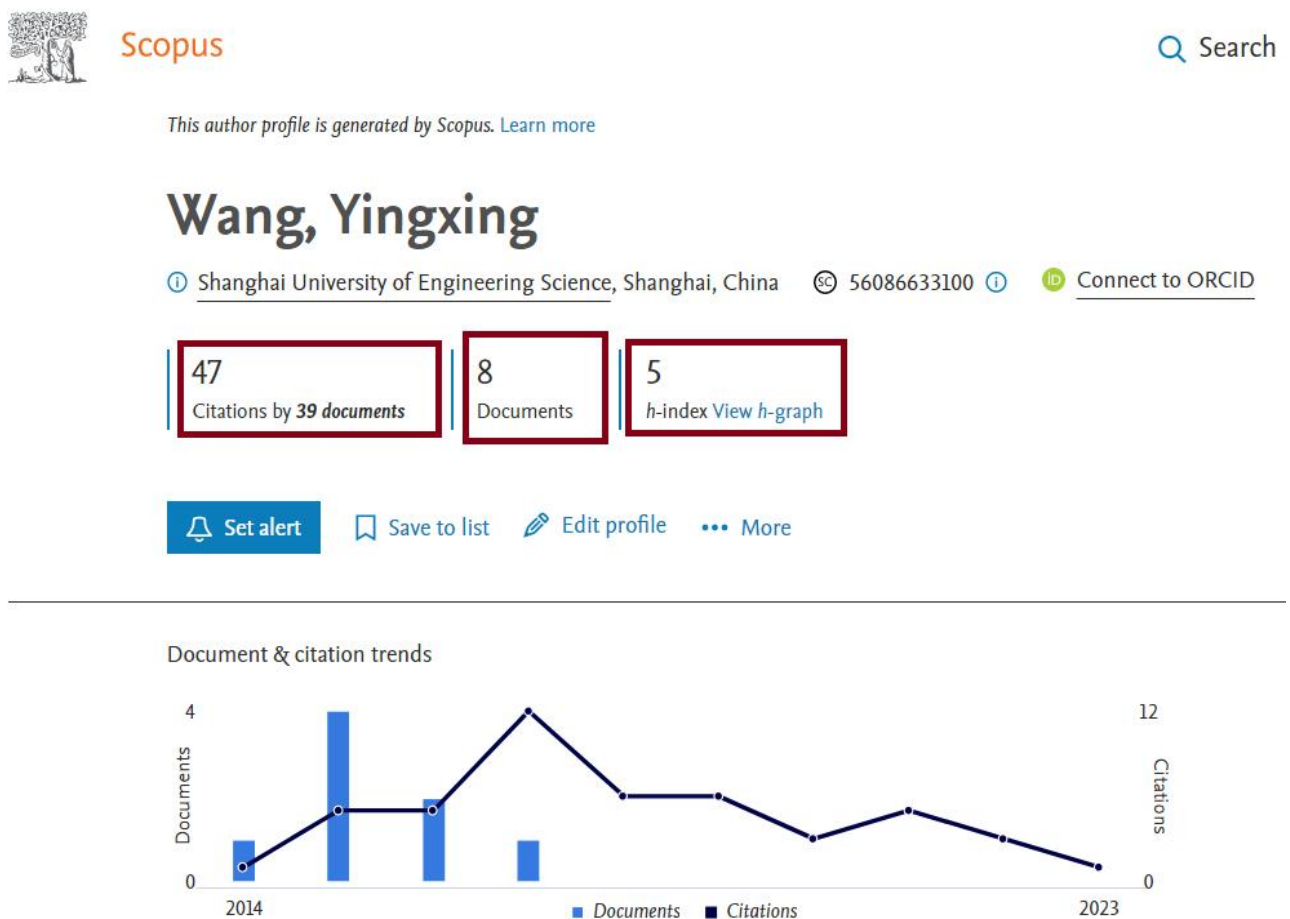


Figure 4.1. – A screenshot of a page from the Scopus database of some of the authors

One of the tools that can be used to assess the qualifications and personal qualities of the executors of educational projects is a questionnaire using the OPQ (Occupational Personality Questionnaire). The OPQ is a widely used psychometric

tool that assesses a person's personality and qualifications about specific project requirements and requirements. Below are general questions that can be used in such a questionnaire:

1. How do you rate your ability to cooperate and work in a team?

Poor - Average - Good - Excellent

2. How do you rate your ability to organize and plan your work?

Poor - Average - Good - Excellent

3. How do you rate your ability to think analytically and solve problems?

Poor - Average - Good - Excellent

4. How do you rate your communication competence and ability to influence others?

Poor - Average - Good - Excellent

5. How do you rate your decision-making ability in stressful situations?

Poor - Average - Good - Excellent

6. How do you rate your goal-oriented and effective ability?

Poor - Average - Good - Excellent

7. How do you rate your ability to self-organize and work?

Poor - Average - Good - Excellent

8. How do you rate your creative thinking and ability to innovate?

Poor - Average - Good - Excellent

9. How do you rate your ability to resolve conflicts effectively?

Poor - Average - Good - Excellent

10. How do you rate your capacity for learning and continuous self-development?

Poor - Average - Good - Excellent

In this case, the rating scale can be displayed by choosing one of the answer options: "Weak", "Average", "Good", "Excellent". The answer to the question "Poor" can be rated 0, "Average" - 1, "Good" - 2, "Excellent" - 3. The sum of points determines the personal assessment of the project executor. Depending on the results, the person who makes the decision concludes with the personal qualities of the performer. Please note that these are only general questions, and a specific

educational project may require other or additional questions that correspond to the specifics of the project and its requirements for executors. The results are normalized to the interval $[0,1]$.

The next position in evaluating the performer's personal qualities is the evaluation of the performer by other project performers. It should be noted that the initial assessment of the new project executor will be equal to 0, then after the start of the project implementation, after some time interval, it is already possible to conduct questionnaires of other project executors regarding the efficiency and competence of the work of their colleagues on the project. For the project executors to evaluate the efficiency and results of the work of other executors, you can use a questionnaire with direct questions and an evaluation scale. Below are general questions that can be used in such a questionnaire:

1. How effective do you consider the work processes and approaches used in the work of this performer?

- very ineffective;
- partially ineffective;
- moderately effective;
- quite effective;
- very effective.

2. How accurate and high-quality do you think the results achieved by this performer are?

- very inaccurate and of low quality;
- partially inaccurate and of low quality;
- moderately accurate and high-quality;
- quite accurate and high-quality;
- very accurate and high quality.

3. How appropriate do you consider the competencies and knowledge that this performer demonstrates in the work?

- very inappropriate;
- partially inappropriate;

- moderately relevant;
- quite appropriate;
- very relevant.

4. How well do you rate communication and cooperation with this artist?

- very bad;
- partially bad;
- average;
- fine;
- very good.

5. How responsible and reliable do you think this performer is?

- very irresponsible and unreliable;
- partially irresponsible and unreliable;
- moderately responsible and reliable;
- quite responsible and reliable;
- very responsible and reliable.

6. What would be your overall assessment of this artist's work?

- unsatisfactory;
- partially satisfactory;
- satisfactory;
- fine;
- excellent.

The rating scale can be represented by different values or numerical ranges corresponding to a specific rating depending on the needs. For example, "1" to "5", where "1" is the lowest level and "5" is the highest level. The total score will determine the evaluation of the performer by other performers of the educational project. It is also important to note that the specific questions and evaluation scale may vary depending on the context, project type, and evaluation needs, so it is recommended to adapt them to specific conditions further. The data are normalized on the interval $[0,1]$.

A separate task of the research is the connection of the scores obtained according to the OPQ questionnaire with the questionnaire for evaluating some performers by other performers. Here you can trace how a specific performer evaluates himself and how he is evaluated by other colleagues on the project. Since the survey is carried out with a certain periodicity, for example, once every six months or once a year, it is possible to trace the dynamics of changes in the evaluation results from the beginning of the project implementation to its completion, that is, during the entire life cycle of the project.

The results are processed, and indicators are normalized and stored for further analysis. Data pre-processing includes:

1. Data validation and cleaning, including data validation for errors, missing values (omissions), abnormal values, or other unacceptable data. Data cleaning is performed if necessary, for example, by filling gaps or removing anomalies.

2. Data structuring, particularly data organization into appropriate formats or structures suitable for further analysis. This may include creating tables, a structured database, or other forms of data organization.

Several approaches and methods exist to check data and clean it of omissions and anomalies programmatically. Here are some of them:

1. Use of software packages for data analysis. Various software packages, such as Python with Pandas and NumPy libraries, R with the dplyr package, or SQL for working with databases, provide convenient tools for data validation, detection of omissions and anomalies, and cleaning them.

2. Detection and processing of gaps. Techniques for dealing with missing data include filling the gaps using mean, median, mode, or other statistical methods and removing rows or columns that contain gaps. Libraries for data analysis provide functions for these operations.

3. Detection and processing of anomalies. Statistical methods, such as sampling outliers based on standard deviation or other measures, or machine learning methods such as clustering, anomaly detectors, or outlier-aware algorithms, can

detect anomalies. These methods can also be implemented using various software packages and algorithms.

4. Data validation. Validating data against specific rules or restrictions, such as value ranges, data types, formats, etc. Validation can be performed using built-in mechanisms in programming languages, libraries or by writing your own code to check data.

The PostgreSQL database was chosen for structuring the data on the evaluations of the educational project performers. The PostgreSQL database is a powerful and extensible solution for storing and structuring data. It provides:

- Opportunities for organizing data in the form of tables.
- Using relational connections between tables.
- Efficient execution of queries.

To save and structure data on the evaluation of knowledge, productivity and personal qualities of the executors of educational projects in PostgreSQL, you can create an appropriate database scheme with the following tables:

1. "Executors" table: Contains information about project executors, such as an identifier (ID) (Primary Key), name, contact information, etc.

2. "Ratings" table: Stores data on evaluations of knowledge, performance and personal qualities of performers. Includes fields that correspond to questionnaire questions or contain assessments, for example: ID (Primary Key), ID of the performer (Foreign Key, refers to the table "Performers"), assessment of knowledge, assessment of performance, assessment of personal qualities, etc.

3. "Projects" table: Contains information about educational projects with which performers are associated. It may include fields such as ID (Primary Key), project name, project start and end date, etc.

The relationships between these tables are as follows: the Scores table has a foreign key Artist ID referencing the ID field in the Artists table. This is a one-to-many relationship because one performer can have many ratings. The Grades table can also have a foreign key "Project ID" that references the "ID" field in the Projects table. This depends on your system requirements and whether the estimates are

project-specific. The "Projects" table has no direct connection with other tables at this description stage. However, if needed, you can use its ID as a foreign key in other tables.

PostgreSQL supports indexing, improving database queries' performance, especially when working with large volumes of data. In general, using the PostgreSQL database provides opportunities for convenient storage, structuring and management of data on the assessment of knowledge, productivity and personal qualities of the performers of educational projects.

4.2. Methods of functioning of information technology to support decision-making

The MonitorCom information system was developed to automate assessing the level of competencies of the executors of educational projects. The system is a part of information technology for decision support. The MonitorCom system belongs to the hybrid type, as it is based on work with a database, tables and methods of monitoring and decision support models for managing educational projects.

The architecture of the built system consists of a task processing system and a data presentation system.

The task processing system consists of the following modules: a module for evaluating the level of competencies of educational project executors, a module for forming a competence environment, a module for monitoring projects, and a decision-making module. Modules can be applied sequentially or individually, depending on the tasks.

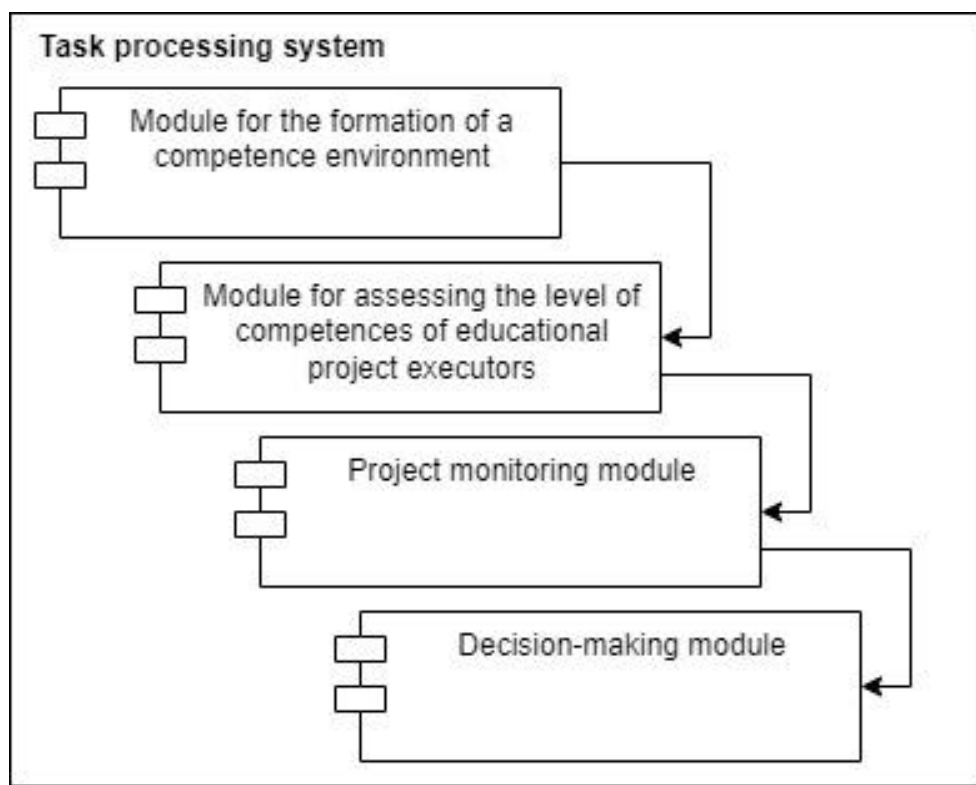


Figure 4.2. – Task processing system modules

Let's consider in more detail the work of the modules of the task processing system. The competence environment building module involves processing a large amount of data collected on the Internet about the scientific and project activity of the project executors. For this purpose, loosely structured data collected from the Internet using the scraping method are verified, structured, and collected in a database. The model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, and the model of the interaction of the executors of the educational project team. These models differ in that the executor in them is not static. He accumulates experience from participation in other projects, giving value to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers. The described models and collected information about all performers are the basis for creating a competent environment for each performer.

The module for evaluating project performers' competencies includes three components: the level of knowledge, productivity, and personal characteristics of performers. In addition, due to the continuous transformation of performers, the information competence environment is transformed along with their performers. It should be noted that determining the mechanism of this transformation is essential for effective monitoring of educational projects. Evaluation of performers is carried out consistently, considering various components of the activity.

The project monitoring module considers project tasks to be completed and results. In addition, the transformation of performers is taken into account. Based on the monitoring results, decisions are made, and criteria and alternatives are formed accordingly. The decision primarily concerns the change in the contribution of the educational project executors. As a result, we should get an increase in the project's assessment. The module allows you to make decisions quickly, and these decisions are justified, do not have subjective influence and are based on open, verified and reliable data.

In Figure 4.3. shows an activity diagram that includes several main related blocks:

- project executors, each of whom has an appropriate competence environment and for whom the assessment of the level of competencies is carried out;
- the university within which the educational project is carried out, the task of which is carried out by the project team, which is formed from the performers, following the assessments of their competencies;
- an information system that collects information about the university, the project and the team of performers, monitors the project and makes decisions about the project's activities, evaluations of the university's activities, etc.

The MonitorCom monitoring information system is a combination of the following:

- a web application that searches, stores and processes significant amounts of information about project executors from the Internet;
- information processing methods;

- sources of information;
- consumers of information (universities and project managers).

A feature of the implementation of services is that each is executed on a separate virtual server, and the interaction between services is implemented using certain APIs. The exchange of information and requests between services takes place through local networks, as well as through the Internet. Data transfer is done using the HTTP protocol by sending POST requests of the appropriate format.

Open data about project executors (their scientific publications, participation in other projects, evaluations and certification, etc.) needs to be more structured and structured. To save and use them, performing structuring and initial processing is necessary. Further, after structuring, the information is placed in the database.

Most of the operations that require a large volume of calculations and access to the database have been transferred to the calculation module. In particular, these operations include: calculating competencies, searching in the database and adding new records regarding citations and publications, and sending e-mails to system users. The Celery server is used to manage background computing tasks. There are two queues of tasks with different priorities on the server. Using two queues allows you to reduce delays in responding to user requests. In addition, to reduce the server load, management of calculation results is applied. For example, if less than a day has passed since the user's R&D calculations were performed, the user will receive the last found result, and no new calculations will be performed.

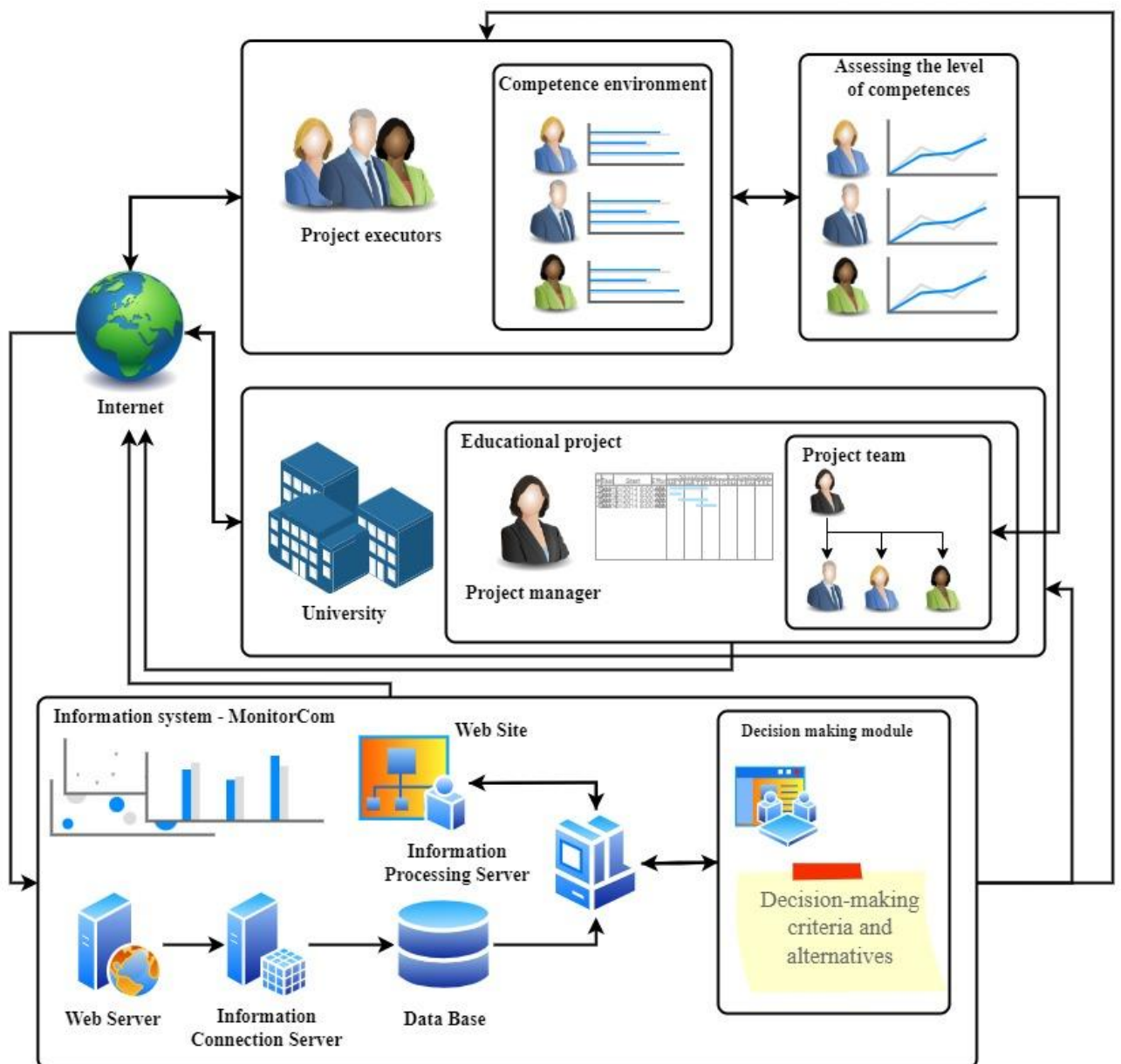


Figure 4.3. - Activity diagram

The module includes spiders for collecting information from international scientometric databases Scopus and Google Scholar, as well as from the website of the National Library of Ukraine and the website of the scientific periodical "Management of Development of Complex Systems". Spiders are implemented using the Scrapy framework and run on the Scrapy virtual server. The capabilities of the module can be easily extended by writing new spiders. Standard Scrapy capabilities are used to manage information collection tasks. The system API is used to save the results to add new objects.

The system records information about universities in which educational projects are implemented separately. All or some of the parameters from the specified list can be stored for university monitoring. Monitoring the effectiveness of the university includes systematic observation of various aspects of its activities to evaluate and improve the quality of educational services, scientific research, administrative management and other vital areas. Some of the key criteria for monitoring university performance are listed below:

Criterion A. Academic quality.

- graduation results of education seekers: number and quality of university graduates, their employment and further career success;
- rankings and reputation of the university: the university's position in national and international rankings.

Criterion B. Scientific research.

- publications and citations: the number of publications in scientific journals and the number of citations, which indicates the impact of research;
- attraction of grants: the number of scientific grants received and the success of their implementation.

Criterion C. Student success:

- the percentage of completed courses: the number of students who completed their studies at the university;
- GPA: level of academic success of students.

Criterion D. Infrastructure and resources:

- university campus: state and development of the campus, availability of modern infrastructure for education and research;
- library funds and access to resources: Volume of available educational and scientific resources.

Criterion E. Attracting and retaining specialists.

- the level of personnel stability: the percentage of specialists who remain at the university for an extended period;

- development of teaching staff: programs for professional development and professional growth of teachers.

Criterion F. Student satisfaction with the learning process:

- student surveys: results of surveys assessing the quality of the educational process, availability of resources and general comfort.

Criterion G. Social interaction and impact on the community:

- project activity: participation of the university in social and research projects aimed at improving public welfare;

- connection with the business environment: cooperation with industry, business and public organizations.

Criterion H. Financial stability and efficiency:

- budget and income: the total funding and income of the university.

- costs and cost efficiency: the ratio between costs and income, rational use of resources.

Each university carries out several educational projects. Each project is associated with a team of performers who are affiliated with the university. The project is managed by a manager affiliated with the university. A competence environment consisting of three blocks is formed for each performer. The first block (assessment of the performer's knowledge) is formed based on open data of the performers from the following parameters:

- the number of certificates in the project's direction with a confirmed passing score of the performer. Each executor or project manager for whom an executor evaluation is conducted uploads certificates to the system for confirmation and the score indicated in the certificate with an assessment in the global system if the score is indicated in the certificate. The specified ratings are used to evaluate the performer in combination with other parameters of their activity;

- the number of certificates of participation in conferences, seminars of the performer. After loading all certificates into the system for each artist, their number is calculated as a regular counter;

- the presence of a scientific degree and academic title in the direction of the topic of the performer's project. These data are indicated in the performer's profile. Further, when calculating the performer's rating, these parameters are transformed in the corresponding scoring system;

- the highest rating the higher education institution has according to the QS system. The rating of the university where the performer works or is affiliated is essential for evaluation. It is assumed that the performer with a high level of qualifications and knowledge works at a university with a high rating according to the QS system. If the performer works at a university for which the rating in the QS system is not determined, then the rating remains equal to 0 for this parameter.

The second block of the competence environment (performance assessment of the performer) is also formed based on open data using the scraping method by viewing pages with verified information about performers. This block includes:

- index of the worst performer. This parameter is determined from the Scopus page of the executor of the educational project. If there is no artist page in this database, then the Hirsch index is zero. The index in the Scopus database that leads to the page and OrcidID with which the performer's profile is associated and the page in Scopus is indicated in the performer's profile;

- the number of scientific publications indexed in the performer's Scopus database. This parameter is also set from the Scopus page of the project executor;

- the number of citations of scientific publications indexed in the performer's Scopus database. This parameter is set from the Scopus page of the project executor;

- The performer created the number of educational modules (authorship confirmed on the project website). This parameter is entered into the system by the project manager or executor with confirmation of information on the sites of the projects within the framework in which the training modules were developed;

- the number of projects in which the performer participated. This parameter is determined by the project manager or executor and is documented.

The third block of the competence environment (assessment of the performer's personal qualities) is also formed based on a survey of other performers of the educational project and a survey of the performer personally. This block includes:

- the results of the modified test for assessing the performer's personality;
- results of the evaluation of the performer by other project performers.

After saving information about educational project executors and forming a competent environment, this information is periodically accumulated and updated according to the activity of the performers, their publication of scientific articles, participation in conferences, certifications, etc. After that, the level of competence of the performers is assessed.

After the formation of the project team, the performers are consistently evaluated based on information about the competence environment of each of them. The assessment of each performer at each stage of the project is saved. The increase in the evaluation of the level of competencies of performers is evaluated. If the increase is positive, then the performer meets the requirements of the project according to the criterion of continuous development of the level of competencies, i.e., he publishes articles, speaks at conferences, is positively evaluated by colleagues on the project, etc. If the increase is equal to zero or close to zero, then the development of the level of competence of the performer does not occur. Accordingly, the project manager needs to carefully analyze the work of this performer and, possibly, exclude him from the project or make other operational decisions that will ensure high-quality project results.

The size of the increment is also essential. Suppose the assessment of the performer's level of competence during the implementation of the educational project goes to one. In that case, the performer meets the project's requirements and shows better results. If the growth of the assessment of the level of competence is slow, then this indicates the low quality of the performer's work. This should lead to the manager making operational decisions to ensure the effective implementation of the project.

A program is used to make decisions, which automatically calculates the assessment of the level of competencies of the project executors and monitors the project as a whole. Monitoring is a complex process consisting of many sub-processes. After monitoring and evaluating performers, the project manager makes an appropriate operational decision. The MonitorCom system consists of a Web Server, Information Connection Server, Data Base, Information Processing Server, a Web site for dialogue with the user, and a decision-making module that considers criteria and alternatives.

The Web Server plays a key role in processing and sending web requests and web pages over the Internet. The primary purpose of a web server is to provide web content to users who interact with it using web browsers. A web server performs several essential functions. Provision of web pages and other web resources (images, video, sound) to users via the Internet. When a user types a website's URL (address) into a browser, the browser sends a request to the web server, which then sends a response in the form of HTML code, which the browser interprets and displays on the screen.

Web servers can handle dynamic content, which means they can generate content on the fly based on user actions or data from databases. A web server receives and processes requests from users' web browsers. It interprets URLs, determines what file or resource to provide, and ensures the resource is returned to the user. Web servers can manage user sessions by storing data about website users. This allows you to maintain authorization and store the state of user interaction. Web servers can store and serve cached content. This helps reduce server load and speed up user access to web resources.

Another component of the system is the database, which is used to store information about performers and their competence environment. The volume of data about performers is quite large. Therefore, the PostgreSQL relational database is used to store information. In general, database types can range from relational (like SQL databases like MySQL, PostgreSQL) to NoSQL (like MongoDB, Cassandra), graph

(like Neo4j), web-distributed (like Firebase), and many others. The built system allows you to connect different types of databases.

The system keeps track of executors of current projects, potential executors who can be engaged to implement new projects and work packages of existing projects. If the executor is connected to a new project, indicators are recalculated for him, and an updated competence environment is formed. It is being built for performers for whom the competence environment still needs to be built.

4.3. Analysis and visualization of data to build information technology to support decision-making

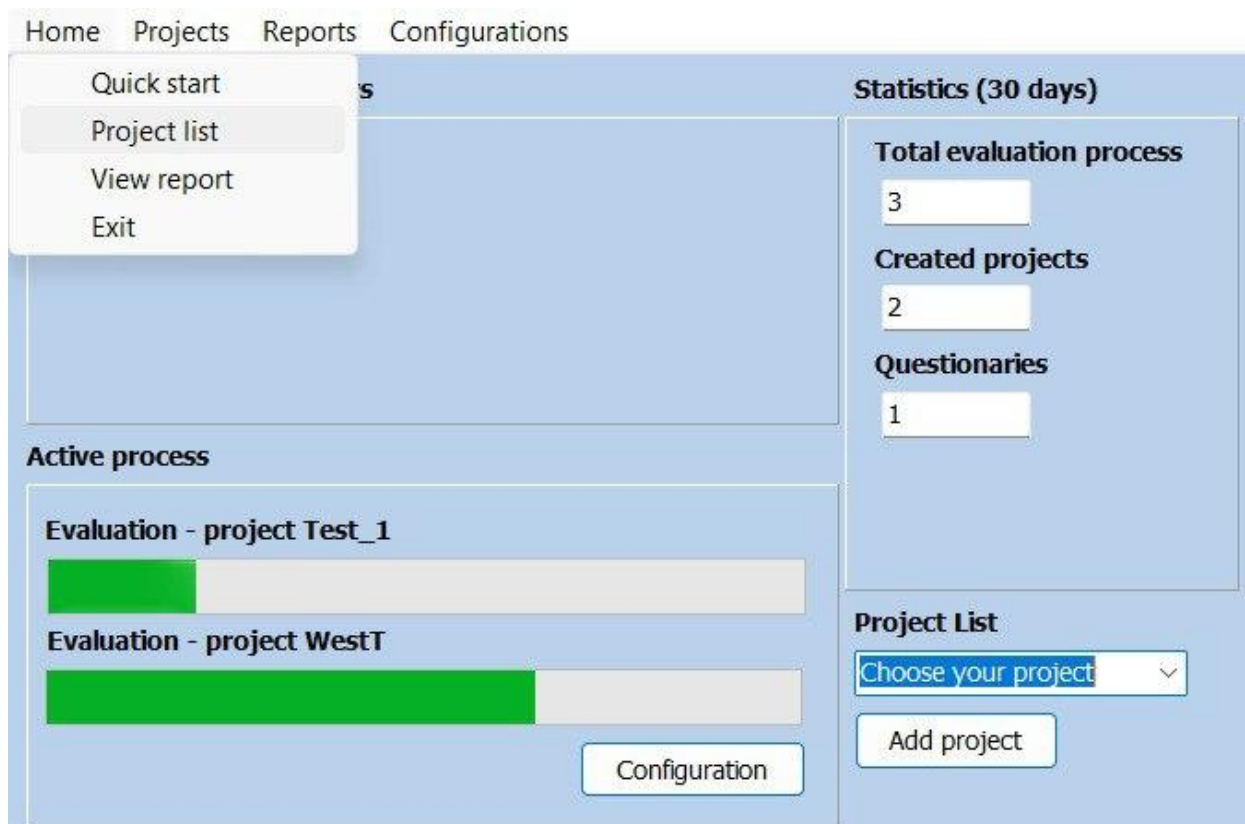
The MonitorCom information system was developed to automate assessing the level of competencies of the executors of educational projects. The system is part of the information technology for monitoring the competencies of the executors of educational projects. It makes it possible to form decisions regarding the selection of potential executors for participation in a specific project, as well as to track the change in the level of competences of the executors of existing projects during the project's life cycle.

The MonitorCom system is designed for system user (project manager) or administrator access. Figure 4.4 shows the system login form. Users who have entered their email address in the profile settings can reset the password, and recovery instructions are sent to the email address specified in the user's profile. The system has several tabs: home, projects, report, and configurations. You can see which processes are currently active and make adjustments to them. It is also fashionable to see general statistics for the last 30 days and add a new educational project. In Figure 4.5. the primary form of the system is shown. In Figure 4.6. statistics of activity in the system for 30 days are also shown. In Figure 4.7. general information about the project is shown: name, description, status, and year of creation.



The login form is set against a light blue background. It features two input fields: one for 'E-mail' and one for 'Password'. Below the password field is a checkbox labeled 'Keep me logged in.' which is checked. At the bottom, there are two buttons: 'Log in' and 'Forgot your password?'.

Figure 4.4. – MonitorCom login form



The main dashboard has a top navigation bar with 'Home', 'Projects', 'Reports', and 'Configurations'. A dropdown menu is open under 'Projects', showing 'Quick start', 'Project list', 'View report', and 'Exit'. The main content area is divided into several sections:

- Statistics (30 days):** A sidebar on the right showing 'Total evaluation process' (3), 'Created projects' (2), and 'Questionnaires' (1), each with a corresponding input field.
- Active process:** A section with two progress bars. The first is 'Evaluation - project Test_1' and the second is 'Evaluation - project WestT'. A 'Configuration' button is located below these bars.
- Project List:** A section with a dropdown menu labeled 'Choose your project' and an 'Add project' button.

Figure 4.5. – The main form of the MonitorCom system

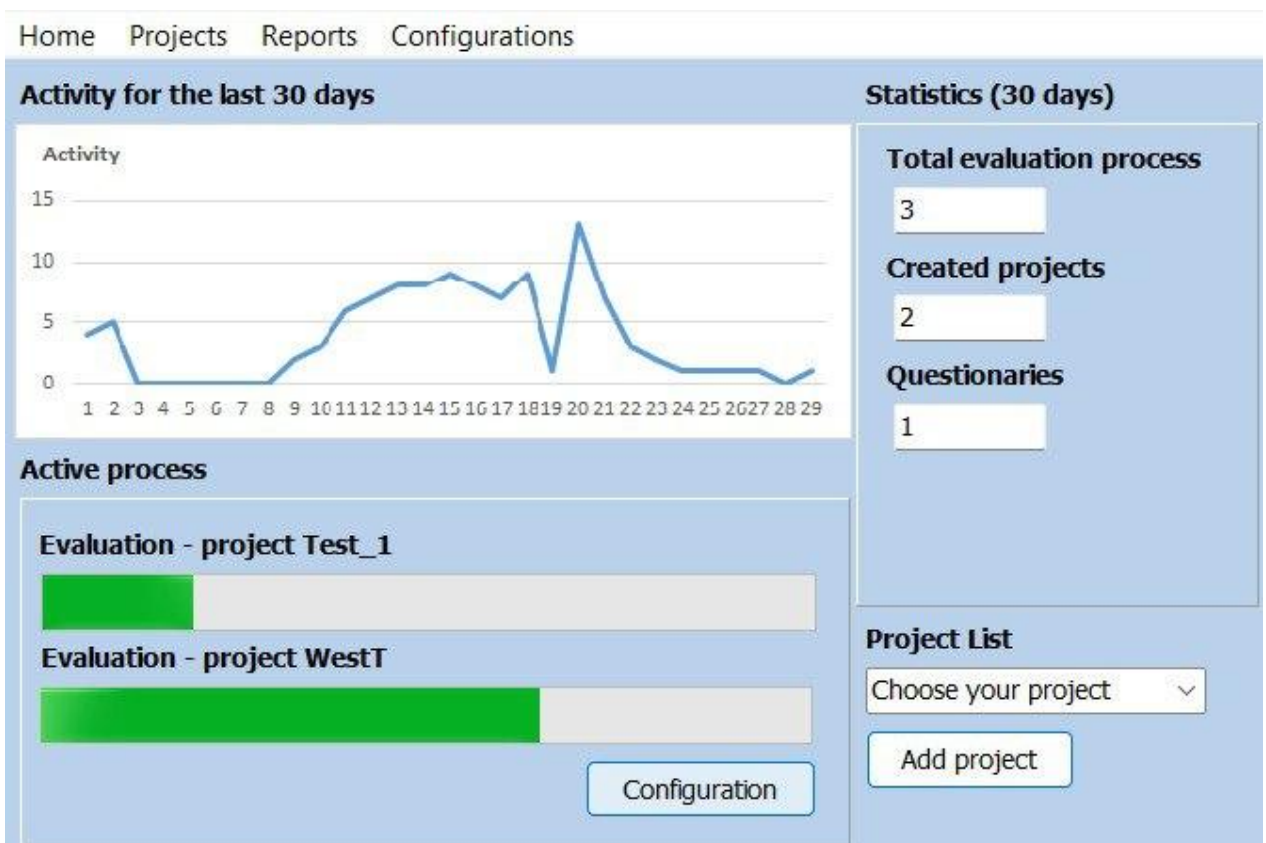


Figure 4.6. – The main form of the MonitorCom system with information about activity in the system

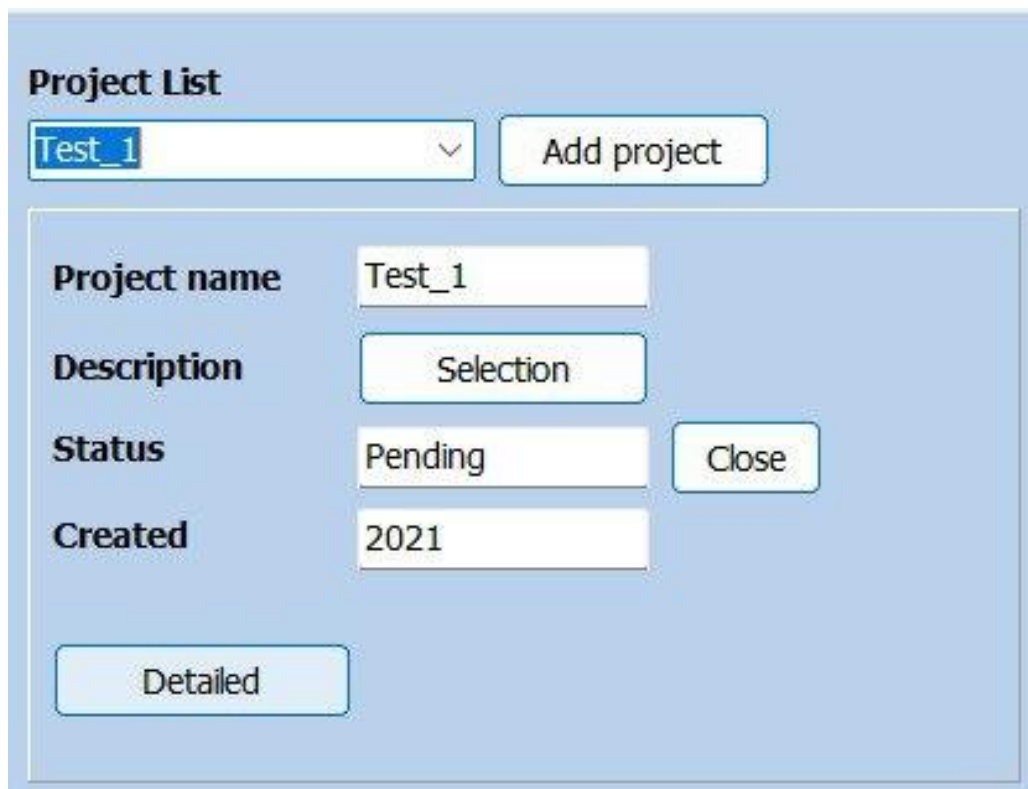


Figure 4.7. – General information about projects in the system

The Report tab contains information about project monitoring results and offers an operational solution that will increase the effectiveness of the project. The manager uses these recommendations to make operational decisions.

In the context of analysis and data collection, the MonitorCom system performs the following functions:

- data collection and preparation. This stage includes the collection of various data sources, cleaning, and processing for further analysis. Data for building competence environments of performers are collected by scraping from the pages of Scopus performers, sites of scientific and educational projects that mention performers. The links provided by the project manager for checking indicators are also verified. Data, in this case, is collected in a structured form and entered into the database. As a result, information competence environments are formed;

- data research. This stage involves the application of various analytical methods to identify dependencies, trends and correlations in the data set. In the context of the MonitorCom system, the evaluation of the level of competencies of the executors of educational projects is carried out, taking into account the dynamics of changes in their information competence spaces and the monitoring of specific educational projects.

In the context of analysis and data collection, the MonitorCom system performs the following functions:

- creation of graphs and charts. Data visualization helps transform complex numerical data into a graphical form that makes it easier to understand. In the context of the MonitorCom system, an activity schedule is created, which shows the statistics of the use of the system for 30 days, a diagram of the implementation of project evaluations, their phasing, project evaluations based on monitoring results, etc.

- user interface and dialog mode with it. The user interface provides and facilitates work with the system, allows you to set the project monitoring parameters, determine the key components of the information competence environments of the performers, and determine the performers included in specific international educational projects.

Also, the MonitorCom system has several important functions that ensure its functioning:

- the system can provide recommendations for making operational decisions by the manager of the educational project or the person who makes the decision and manages the project. At the same time, a recommendation is formed by the decision-making method based on the data according to the specified criteria and alternatives, which are considered in chapter 3;

- the system is flexible, as it is developed as a set of microservices, which ensures its integration with other systems if necessary. This position is important because specific systems are often used in the execution of projects, which require evaluations based on the results of project monitoring and evaluations of project executors;

- maintaining data security and confidentiality is critical for systems that rely on data analysis and processing. That is why the system is provided with password protection against unauthorized access. The system contains significant information about performers' ratings, their participation in projects, completed training modules and their implementation, certification and advanced training, etc. The data is not confidential because it is freely available on the Internet, and, for the most part, the data entered by the project manager or executor is quantitative and does not contain personal information that could harm the owner. However, all the same, the system must have protection against access by third parties, which can harm the regular monitoring of projects and thus cast doubt on the results of monitoring.

4.4. Support for the decision-making process

The decision-making process is a set of actions, tools, and methods that help individuals, organizations, or groups make sound, practical and informed decisions in various areas of life. This process includes several steps and functions to analyze and choose the best possible course of action. In the context of monitoring international educational projects, support for the decision-making process is provided by a

continuous procedure for collecting data from open sources, processing it, and entering it into the database. That is, there is a dynamic formation of the informational competence spaces of the executors of educational projects. This is a feature of the MonitorCom system. Supporting the decision-making process can use various tools, including analytical methods, mathematical models, software, qualified specialists, and consultants. Here are the main decision support components that can be used in the MonitorCom system:

1. Definition of goals. Establishing and specifying the goals to be achieved. Clearly defined goals help align decisions with desired outcomes. The goal of the MonitorCom system is to collect open data on the results of work on the activity of educational project executors and to evaluate their performance. As a result, based on the determined assessments of the competence levels of the performers, calculate the productivity and potential of the actual educational projects. Moreover, the evaluation process must involve the use of information about the activity of performers, which is dynamically collected and constantly replenished and updated.

2. Collection and analysis of information. Gathering the necessary information, data, facts, research and statistics related to the situation for which a decision must be made. As already indicated, the collection of information is done by scraping from sites containing information about the executors of educational projects: their participation in the projects, Hirsch indices, the number of citations of scientific publications, etc. All this information is necessary to form the performer's competence environment fully. In addition, part of the information necessary for the construction of informational competence environments should include the results of a survey of the performer and other performers with whom this performer cooperates in the direction of specific educational projects.

3. Identification of options. Development of various possible options for solutions that can solve the set goals. For this purpose, to ensure the procedure of formation of recommendations for decision-making by the project manager, six operational goals are established in the MonitorCom system, based on which decisions are determined. These operational solutions are described in Table 3.3.

4. Evaluation of alternatives. Assessment of positive and negative aspects of each decision option and identification of risks and possible consequences.

5. Choosing the optimal solution. Choosing the option that best meets the objectives, has the best balance of pros and cons, and can be implemented with available resources.

6. Implementation of the decision. Development of a plan for the implementation of the chosen decision and implementation of the necessary steps for its implementation. After receiving the results of project monitoring and evaluations of the competence levels of the project executors, the project manager determines which operational goals to adopt.

7. Monitoring and evaluation of results. Tracking and analyzing the results of the implemented solution, evaluating its effectiveness and identifying possible adjustments. After making an operational decision, the manager or the person making the decision evaluates the effect of deciding on the project's progress. The evaluation of the implemented solution on the example of the MonitorCom system is shown in fig. 3.13.

8. Adaptation and adjustment. It is used, if necessary, to make changes to an already adopted decision to improve the results.

9. Involvement of experts and employees. Expert advice, consultation with colleagues and the involvement of internal or external expertise help make informed decisions.

10. Communication: Explain decisions and rationale to all stakeholders to ensure understanding and support.

4.5. Scientific and practical significance of the developed software

The scientific and practical value of the developed software of the MonitorCom system can be divided into separate modules:

1. The proposed module for building a competence environment makes it possible to formalize and combine in one structure the information about the activity of the performers of the educational project, which includes the assessment of

knowledge, the assessment of productivity and the assessment of the personal characteristics of the performer. Data is collected by the method of scraping from the Internet, the method of verification of entered data based on open sources of information, and the survey method. The informational competence environment of the performers is formed dynamically, which accordingly reflects on the general assessment of the performer. Loosely structured data collected from the Internet using the scraping method are verified, structured and collected in a database. To fully ensure the presentation of these data, the model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, and the model of the interaction of the executors of the educational project team are used. These models differ in that the executor in them is not static. He accumulates experience from participation in other projects, giving, in turn, values to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers.

2. The proposed module for evaluating project performers' competencies includes three components: the level of knowledge, productivity, and personal characteristics of performers. In addition, due to the continuous transformation of performers, the information competence environment is transformed along with their performers. It should be noted that determining the mechanism of this transformation is essential for effective monitoring of educational projects. Evaluation of performers is carried out consistently, considering various components of the activity. Evaluation data are collected in various ways: some are collected from the Internet from open, reliable sources of information, others are verified, and others are formed as a result of surveys. All these data are structured in the database and determine the information competence environment of the performers.

3. The project monitoring module includes consideration of project tasks that must be completed and project results. In addition, the transformation of performers is taken into account. Based on the results of monitoring, operative decisions are

made by the person making the decision or the project manager. The decision primarily concerns the change in the contribution of the educational project executors. As a result, we should get an increase in the project's assessment. The module allows you to make decisions quickly, and these decisions are justified, do not have subjective influence and are based on open, verified and reliable data.

The practical significance of the obtained results is that the developed decision-making models and information technology for monitoring educational projects based on the competence approach are the basis for ensuring the effectiveness of educational projects designed to improve the quality of educational process provision. Using theoretical and practical results will provide an opportunity to improve the quality of implementation of international educational projects and increase the competence level of the executors of such projects.

The practical value is that as a result of the work, information technology was developed and implemented to support decision-making regarding the management of educational projects based on a competency-based approach to the composition of their executors. Mathematical and software individual modules of the system for monitoring international educational projects have been developed.

The obtained results of both a theoretical and practical nature are the basis for further research aimed at improving and ensuring the sustainability of the development of higher education institutions, which meets the requirements of international systems for monitoring their activities, taking into account changes in the competences of executors of educational projects that are carried out in these institutions of higher education. The main provisions and results of the research were implemented and applied in the activities of Zhejiang ACME Information Technology Co. LTD.

Conclusions to Chapter 4

1. Verification of research results was carried out. The stages of creating information technology for decision-making support for monitoring the level of competence of educational project executors are described: analysis of the

needs for the construction of information technology, collection, and processing of data required for the construction of information technology for decision-making support, analysis, visualization, and modeling.

2. The task processing system is described, which consists of the following modules: the module for assessing the level of competencies of the executors of educational projects, the module for forming the competence environment, the module for monitoring projects, and the decision-making module. Modules can be applied sequentially or individually, depending on the tasks. The activity diagram and primary forms of the MonitorCom monitoring information system are described.
3. The information technology of decision-making support for monitoring educational projects has been improved, which differ from the current ones in the comprehensiveness of the approach to monitoring, taking into account the composition and dynamics of the information competence environments of the executors of educational projects. Information competence environments are formed before monitoring, which dynamically changes.
4. The developed information technology provides a toolkit for project managers and institutions of higher education for managing educational projects, particularly to increase their results' effectiveness. As a result, the project manager can apply a system of material incentives to increase the motivation of project executors. In conditions of limited resources, this is of great practical importance. The scientific provisions and practical results described in the work are important for managing educational projects and increasing the rating of project executors, i.e. scientists, as well as increasing the evaluation of the universities where they work.

CONCLUSIONS

The dissertation solves an important task, namely: the development of mathematical methods for monitoring educational projects of a complex structure in dynamics and decision-making models for quality management of educational projects (scientific component), as well as the development of information technology for monitoring educational projects in dynamics, which allows automating the collection processes data and their processing (practical component).

The practical significance of the obtained results is that the developed decision-making models and information technology for monitoring educational projects based on the competence approach are the basis for ensuring the effectiveness of educational projects designed to improve the quality of educational process provision. In the short term, using theoretical and practical results will provide an opportunity to improve the quality of implementation of international educational projects, such as Erasmus+, Jean Monnet, etc. It will also allow to increase the level of competence of the executors of such projects. In the long term, the use of the developed approaches will positively impact the development of the quality of education as a whole.

The obtained results of both a theoretical and practical nature are the basis for further research aimed at improving and ensuring the sustainability of the development of higher education institutions, which meets the requirements of international systems for monitoring their activities, taking into account changes in the competences of executors of educational projects that are carried out in these institutions of higher education. The main provisions and results of the dissertation research have been implemented and applied.

The conducted studies give grounds for drawing several conclusions:

1. Peculiarities of the formation and implementation of educational projects in universities are considered. Five stages are identified that determine the life cycle of an educational project, including initialization, planning, implementation, monitoring and completion. For educational projects, an important addition to these components is the use of the competence method of

evaluating the performers of the educational project in dynamics. This will allow tracking the change in productivity ratings, knowledge level, and personal characteristics ratings of the project performers during the implementation of the educational project and, as a result, increase the effectiveness of the project. As a result, the application of competence methods in implementing educational projects is described.

2. It was established that taking into account the dynamics of transformation and development of the competencies of performers and the connection of this development with the tasks of a specific project is unresolved. To ensure effective planning and monitoring of an educational project, it is advisable to build information technology to support decision-making based on competency-based methods. The development of such a system is important for the educational system of the People's Republic of China, as universities manage many educational projects with a large number of students, which requires an innovative monitoring system. In the course of the study, the main elements and ways of building such monitoring information technology were determined, which includes the development of methods for forming the information environment of performers, the creation of methods and models for evaluating the level of competences, methods for evaluating the performance of project performers and the potential of the project.

3. The model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, the model of the interaction of the executors of the educational project team were developed and described. These models differ in that the executor in them is not static, he accumulates experience from participation in other projects, giving in turn, values to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers. The model of identification of

the executor of the educational project is at the basis of the formation of information competence environments.

4. The method of forming informational competence environments of performers of educational projects, which differ in the complexity of the approach to assessing the level of competencies, taking into account the level of knowledge, productivity and personal characteristics of the performers, has been developed and described. The defined models and features of building an informational competence environment are the basis for further evaluation of the performance of educational project executors, the project's potential and, in general, are an important stage of ensuring the monitoring of the educational project as a whole. The relationship between the composition of the competence environment of the executors of educational projects and the potential of the projects is shown. To verify the described construction method, ten educational projects were selected, which were implemented from 2014 to 2020. The results indicate that the assessment of project executors' competencies recorded at the end of the project almost entirely coincides with the assessment of evaluators after the completion of the projects. The ranks obtained after the final assessment of the projects and the ranks based on the calculated performance estimates coincide by 40%. Project evaluation is mainly focused on the reputation and productivity of performers and does not sufficiently consider the transformation of performers' competencies during the implementation of projects.

5. The developed methods of monitoring educational projects based on the dynamics of their information competence environment are described, based on open data of performers. They can be used in planning and managing an educational project at each stage of its implementation. Further development of the decision support model for monitoring educational projects based on the dynamics of informational competence environments and models of identification of educational project executors was obtained, expanding the theoretical and practical possibilities of ensuring the effectiveness of

implementation, planning and management of educational projects. Indicators of the competencies of the executors of educational projects are described. The possible operational goals of the decision-maker, i.e. the project manager, are given. Based on an actual project implemented in Yancheng Polytechnic College from 2014 to 2020, an operational solution proposed based on calculations showed a 3.74% increase in overall project evaluation. This percentage was obtained by constructing asymptotes corresponding to the ideal performer (upper asymptote) and the worst performer (lower asymptote).

6. The stages of the creation of decision-making support information technology for monitoring the level of competencies of educational project executors are described: analysis of information technology construction needs, collection and processing of data required for the construction of decision-making support information technology, analysis, visualization, and modeling. The task processing system, which consists of the following modules, is described: the module for assessing the level of competencies of the executors of educational projects, the module for forming the competence environment, the module for project monitoring, and the decision-making module.

7. Thus, the information technology of decision-making support for monitoring educational projects has been improved, which differs from the current ones in the comprehensiveness of the approach to monitoring, taking into account the composition and dynamics of the information competence environments of the executors of educational projects. That is, information competence environments are formed before monitoring, which dynamically changes. The developed information technology provides a toolkit for project managers and institutions of higher education for managing educational projects, in particular, to increase the effectiveness of their results.

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<http://dx.doi.org/10.1109/TEM.2007.900797>

APPENDIX A. ACT OF IMPLEMENTATION



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

ACT OF IMPLEMENTATION

THE ACT OF IMPLEMENTING THE RESULTS OF THE DISSERTATION

WORK OF PHD STUDENT WANG YINGXING

DECISION-MAKING SUPPORTS MODELS AND INFORMATION TECHNOLOGY FOR MONITORING EDUCATIONAL PROJECTS BASED ON ASSESSING THEIR EXECUTORS' COMPETENCIES

THE ACT WAS DRAWN UP BY A DIRECTOR OF

ZHEJIANG ACME INFORMATION TECHNOLOGY CO. LTD JIYONG YAN

ZHEJIANG ACME INFORMATION TECHNOLOGY CO. LTD considered in detail the results of Wang Yingxing's dissertation research, "**Decision-making supports models and information technology for monitoring educational projects based on assessing their executors competencies**" and established:

1. Wang Yingxing has been actively cooperating with the company for the past few years, especially on her dissertation research topic. The commission believes that Wang Yingxing's dissertation research, "Decision-making supports models and information technology for monitoring educational projects based on assessing their executors competencies" is of significant practical interest to institutions of higher education, educational institutions, and organizations implementing international educational projects.
2. In work, the model of identification of the executor of the educational project, the model of the interaction of the executor of the educational project with another project, and the model of the interaction of the executors of the educational project team were developed. These models differ in that the performer in them is not static. He accumulates experience from participating in other projects, giving, in turn, values to other projects in which he participates. The models describe the continuous process of improvement and transformation of the performers of educational projects and indicate the impact of this improvement on other projects performed by these performers.
3. The work has developed and described a method of forming informational competence environments for performers of educational projects, which differ in the complexity of the approach to assessing the level of competencies, taking into account the level of knowledge, productivity, and personal characteristics of the performers. The defined models and features of building an informational competence environment are the basis for further evaluation of the performance of educational project executors and the project's potential and, in general, are an essential stage of ensuring the monitoring of the educational project as a whole.
4. Methods of monitoring educational projects have been developed based on the dynamics of their information competence environment, which are based on open data of performers and can be used in planning and managing an educational project at each stage of its implementation. Further development of the decision support model for monitoring educational projects was obtained based on the dynamics of informational competence environments. Information technology for decision-making support for monitoring educational projects has been developed.

The decision of the commission:

The decision-making support information technology for monitoring educational projects developed by Wang Yingxing as part of the dissertation research "**Decision-making supports models and information technology for monitoring educational projects based on assessing their executors competencies**" provides a powerful toolkit for managers of educational projects, institutions of higher education and their management for managing educational projects, improving the effectiveness of their results. The analysis of the work results testifies to the practical value of its scientific work, expanding the theoretical and practical possibilities of ensuring the effectiveness of implementing, planning, and managing international educational projects. The committee members believe that Wang Yingxing deserves to be awarded a Ph.D. in Computer Science 122.

Zhejiang ACME Information Technology Co. LTD JIYONG YAN

TEL 0086-575-83267001

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

11.05.2023

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

Articles in professional publications of Ukraine

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

1. **Wang, Ying Xing.** (2020). Development of the model for the recognition of competencies for the personnel of mortgages. *Management of development of complex systems*, 41, 109 – 114, dx.doi.org\10.32347/2412- 9933.2020.41.109-114. [category «B»]
<http://urss.knuba.edu.ua/files/zbirnyk-41/17.pdf>
2. **Wang, YingXing.** (2019). Development of a decision support system for organizing distance learning. *Management of development of complex systems*, 37, 121 – 126, dx.doi.org\10.6084/m9.figshare.9783125. [category «B»]
<http://urss.knuba.edu.ua/files/zbirnyk-37/21.pdf>
3. Kuchansky A., Biloshchytskyi A., Andrashko Y., **Wang, Yingxing.** (2022). Devising a competence method to build information spaces for executors of educational projects in a dynamic environment. *Eastern-European Journal of Enterprise Technologies*. 1(3(115)), 66–73. doi: 10.15587/1729-4061.2022.253043 [the publication is indexed in Scopus, category «A»]
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4067781
4. **Wang, YingXing.** (2022). The method of forming informational competence spaces for educational project executives. *Management of Development of Complex Systems*, 52, 66–72, dx.doi.org\10.32347/2412- 9933.2022.52.66-72. [category «B»]
<http://urss.knuba.edu.ua/files/zbirnyk-52/66-72.pdf>

Articles in professional publications of Ukraine

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

1. **Wang, YingXing.** (2020). Selection criteria for improving the professional competence of Chinese teachers in Ukraine. *Science Journal Innovation Technologies Transfer*. 65-69. 10.36381/iamsti.4.2020.65-69.
<http://www.iamsti.org.ua/sjitt-2020-4-09/>

Approbation works

1. **Wang, YingXing,** Ryzhkov, O. (2021). Progress of a model for determining the proficiency of the educators. 2021 IEEE Smart Information Systems and Technologies (SIST), 1–5, doi: 10.1109/SIST50301.2021.9465933 [**Scopus, Web of Science**]
2. **Wang, Ying Xing.** (2018). Management of international competence development projects in dynamic environment. *V international scientific and practical conference "Information technologies and interactions"*, 66-67.
3. **Wang, Ying Xing.** (2019). Decision support system for distance education. *Conference «Management of projects in the development of society»*, 53-54.
4. **Wang, Ying Xing.** (2019). Support system for online education. *I international scientific-practical conference, IMTSK-2019 (Information Modeling Technologies, Systems and Complexes)*, 2019, 116-117.
5. **Wang, Ying Xing.** (2020). Модуль для визначення компетентності персоналу викладачів. *Seventh international scientific-practical conference «Management of the development of technologies» Topic: "Information technology development of educational content» Kyiv, 25 – 26 March 2020*, 139-140.