

Performance Efficiency of University Teachers in the Context of Generational Balance: Measurement Tools and Application Mechanisms

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Abstract

The views of scientists on the problem of the generational theory in the field of higher education and science are presented. The use of tools for measuring teachers' performance on the example of international scientometric databases and local systems for automated determination of performance results is presented, the prospects of its scalability in higher education institutions is proved. The dependence of the rating indicators of teachers' performance on the age of scientific and pedagogical workers is experimentally studied. The generational balance of teachers of higher education institutions is studied on the basis of the analysis of the ratio of age and publication activity of the most productive TOP teachers of universities occupying different positions of the consolidated ranking. A SWOT analysis of the generational balance of teachers of higher education institutions was conducted. The tendency of decrease of the percentage of young scientists among university teachers is revealed, the possible consequences are analyzed. The mechanisms of application of tools for measuring the university teachers' performance depending on the age category are described. The imbalance of different age groups of teachers indicates high risks of a generational conflict and may lead to a reduction of performance efficiency in the future. Performance measurement tools are an important factor for the implementation of educational management of higher education institution.

Keywords

Generational balance, rating indicators, measurement tools, information and analytical measurement systems, publication activity

1. Introduction

The priority tasks of the development of the national higher education system in the modern information society include integration into the global scientific community, as well as the development of an innovative educational ecosystem. The systemic transformation of higher education is aimed at ensuring a new quality, which, in turn, is impossible without the effective activities of university teachers and sound management decisions.

The modern theory and practice of personnel management in higher education institutions should be based on the principles of result-based management and take into account the influence of cardinal changes in the age structure of scientific and pedagogical personnel due to such factors as:

- Demographic imbalance.
- Increased outflow of personnel from the field of science and higher education to other areas of activity.

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- The tendency to declining the number of young scientists.
- "Aging" of scientific and pedagogical staff.

In this regard, in the framework of the analysis and determination of priority directions for the building of the universities' human capacity, we consider it appropriate to use the developments of the Strauss–Howe generational theory, created at the intersection of economic, sociological, historical and psychological sciences [13]. This approach to considering issues related to the human factor in management is gaining considerable relevance in modern research and is used to solve practical problems in the field of education and science.

Analysis of the performance efficiency of university teachers in the context of generational balance is presented in many studies, caused by concerns about changes in the age structure of universities' personnel and, as a result, the loss of potential productivity.

However, despite the big amount of scientific researches, there are many cases of conflicting results, in particular due to different statistical methodologies and the lack of a unified model for measuring teacher performance.

An analysis of the relationship between research performance, age, and seniority in academic rank of full professors in the Italian academic system is presented in the paper 'The combined effects of age and seniority on research performance of full professors' (2015) [1]. The analysis shows that with increasing age there is a significant decrease in the effectiveness of professors. However, in such disciplines as biology, chemistry and medicine, work experience within the rank of professor has a positive effect on the effectiveness of teachers. This result could be explained by the "accumulative advantage" effect. The authors adopt a measurement method based on comparative evaluation of performance by academics in the same field and in the same academic rank. The study was based on publications indexed in the Web of Science (WoS).

However, the analysis which is based only on the data of the bibliometric database Web of Science often produce a distorted picture of the research output in some disciplines, in particular the social sciences, arts and humanities, where a substantial share of relevant journals or books are not indexed in the Web of Science [3].

The dependence of the results of universities teachers' performance on belonging to the age category is outlined in the paper 'Age and scientific productivity. Differences between fields of learning' [6]. A cross-sectoral study shows that publishing activity peaks in the 45-49 age group and decreases by 30 percent among researchers over the age of 60. However, there are great differences between fields of study. In the social sciences, productivity remains at the same level in all age groups. In the humanitarian field, publishing is declining in the 55-59 age group, but it is reaching a new peak in the 60s age group. Productivity in the medical sciences decreases among teachers over the age of 55, while in the natural sciences productivity declines steadily with age [6].

The issue of the performance efficiency of scientists in the context of the generational balance is relevant for educational and scientific institutions of the United States. The tendency to declining the number of young scientists due to demographic imbalance is observed in scientific institutions and universities of the country. For example, a study of the employees of National Institutes of Health (NIH) at the US Department of Health and Human Services shows that the average age of leading scientists has increased from 30-40 years old in 1980 to 48 years old in 2007. The number of leading researchers over the age of 36 decreased from 18% in 1983 to 3% in 2010 [15].

Taking into account the rapid demographic changes of universities collectives, the tendency to declining the number of young scientists and the associated general "aging" of scientific and pedagogical staff, the study of the generational balance of scientific and pedagogical staff of universities allow to develop effective personnel management policy at the present stage and outline prospects for the of institutions' development to further increase the general performance efficiency of teachers.

The aim of the article is an analysis of the universities teachers' performance efficiency in different areas in the context of generational balance by using the information and analytical systems, including automated.

2. Measurement Tools

The analysis of teachers' performance requires the use of appropriate tools that would take into account the peculiarities of the functioning of universities. Modern information and communication system provides a wide range of such tools.

Today, there are a large number of international bibliographic databases, which are traditionally the focus of scientists, the subject of research of which is the performance of university teachers. The most authoritative are Web of Science and Scopus, generally recognized by the world scientific community.

The process of developing digital services for monitoring the activities of university teachers at the level of individual countries is gaining wide popularity. A good example of such a service is the Norwegian bibliometric database Current Research Information System in Norway² (Cristin), which includes all types of scientific publications in all fields of research in higher education. This database includes all types of scientific and scholarly publications, in all fields of research in the higher education sector. Bibliographic data are collected through a common documentation system used by all institutions, resulting in complete, verifiable and structured data for use in bibliometric analysis. Publication data from professional bibliographic data sources (e.g. the Web of Science) are imported to the Cristin system. Thus, it is a unified database that contains all the metadata needed for further analysis of issue in different areas [5]. The Norwegian bibliometric model has also been used by developers in Denmark, Belgium, Finland and Portugal. The system retains its basic structure, but has been adapted to the specific needs of each country.

In Ukraine, there is an information-analytical system Bibliometrics of Ukrainian Science³ which is designed to provide society with a holistic picture of the state of the domestic scientific environment, the presentation of its sectoral, regional and departmental structure. The source base of the system is the bibliometric profiles created by scientists on the Google Scholar platform, which contain verified information about the results of publishing activities. 'Bibliometrics of Ukrainian Science' operates in test mode. Its development involves, first of all, the expansion of information and resource base - full coverage of existing profiles and methodological assistance to their creation by scientists and teams, which will provide a more objectively statistically accurate picture of the state of science in Ukraine.

The most common way to measure the effectiveness of teachers at the local level of some universities in Ukraine is the use of rating system with the help of modern information and communication technologies.

Thus, at Borys Grinchenko Kyiv University a methodology for internal rating of university departments, which is based on the parameters of the Webometrics rating system was developed. The methodology of the internal rating of structural subdivisions of Borys Grinchenko Kyiv University includes nine indicators in three directions: 'Visibility', 'Quality', 'Transparency' [2]. The direction 'Visibility' is determined through Impact - the total number of all external links that the university receives from third parties (citation of web pages). The 'Quality' direction includes the index of publishing activity (defined as the ratio of the dynamics of uploaded publications in the institutional repository for the previous month to the number of full-time employees according to the rating assessment 'Leader of the Year'). The direction 'Transparency' consists of the h-index, the number of bibliographic references in the Google Scholar profile and the value of the i10-index of the Google Scholar profile [4].

At the National Technical University of Ukraine 'Igor Sikorsky Kyiv Polytechnic Institute' the rating of research and teaching staff is based on the results of annual evaluation of their activities on a scoring system (according to defined and approved by the University Scoring Standards) and with the help of the automated system 'Rating of scientific and pedagogical workers'. The system 'Rating of scientific and pedagogical workers' provides optimization of the number of indicators that objectively characterize the activities of each participant of the rating. The developed system provides presentation of scientific and pedagogical workers' ratings in the form of histograms in sections: university, faculty (institute), department. The results of the rating are an information base for management decisions by the administration of structural units as an important tool of the management system at the university [7].

² <https://www.cristin.no/english/>

³ <http://nbuviap.gov.ua/bpnu/>

At N. E. Zhukovsky State Aerospace University 'Kharkiv Aviation Institute' the evaluation of teachers' performance is carried out using the online information and rating system 'Rating of scientific and pedagogical staff of KHAI'⁴. Determination of the rating of scientific and pedagogical workers, departments and faculties is carried out on a point system by means of a set of elementary completed activities that are included in the corresponding areas of activity [8].

The performance of teachers of Simon Kuznets Kharkiv National University of Economics is measured using the software of the corporate management information system of S. Kuznets KhNUE (KISU). The software subsystem "Rating of teachers" allows to quickly enter data and obtain the results of rating assessment of scientific and pedagogical staff (according to the categories of participants defined in the rating), departments, faculties [10].

For automatic construction of consolidated rating of scientists, departments, faculties according to indicators of processed scientometric systems, an online service 'Publication'⁵ was developed at Kherson State University (hereinafter - KSU), which has been operating since 2018 [12].

We highlight the following main characteristics of the local rating system of publication activity of University educational process' participants on the basis of the online service 'Publication':

Table 1

The main characteristics of the online service «Publication»

Evidentiary and reliability	The system works on the basis of processed scientometric indicators: 1. <i>h</i> -index (Scopus & Google Scholar); 2. citations (Scopus & Google Scholar). Numbers of total citations of documents that are indexed by the system; 3. publications (Scopus). Total number of documents that are indexed by the system.
Scalability and reproducibility	The local system of rating the publishing activity of participants of the educational process of the University on the basis of the online service 'Publication' according to its main characteristics fulfills the needs of Kherson State University for automated calculation of research and publishing activities as a typical institution. .
Accessibility	Availability of open access to the results of publishing activity of KSU teachers according to scientometric databases.

The presented systems and services differ in areas of application, methods of analysis and evaluation criteria, but currently there is no unified automated system in the world that would allow a comprehensive assessment of teachers' performance, taking into account age contexts. Due to the lack of a unified service for monitoring the types and efficiency of university teachers' performance, there is a need, on the one hand, to develop appropriate digital services, and on the other hand, further automation of existing services to objectify data.

3. Experimental study

⁴ <https://rating.khai.edu/>

⁵ <http://publication.kspu.edu/>

The solution of educational issues is impossible without changes in the management system at the university and the creation of an information management system for activities. The information system of the faculty, department as structural educational and scientific divisions of the university is the key element of the functioning of such an information system and the implementation on its basis of the system for determining the ratings of scientific and pedagogical workers, departments and faculties [2].

3.1. The ratio of age categories of teachers and their publishing activity

The analysis of the sources allowed us to determine the following functions of the teacher rating:

Table 2

Functions of the teacher rating

Information function	The general component of ratings of teachers of higher education institution allows entrants to receive information about the university.
Career guidance function	Information on the results of the ranking can be a factor in the choice of the entrant of the higher education institution.
Image function	The rating helps to form the image of the teacher and the higher education institution.
Motivational function	Rating has stimulating properties, because as soon as the department, faculty, institute, university introduces a rating assessment of the teacher, the entire teaching staff seeks to improve their performance, which affects it [13].
The function of professional growth	Ranking contributes to the professional growth of the entire teaching staff of the university.

To solve the problem of assessing the quality of teachers' activities will help measure the performance of teachers, which aims to improve the professional and pedagogical skills of teaching staff as a direct and indisputable prerequisite for the performance of higher education. We analyzed the ratio of age and research and publishing activities of the TOP-20 best scientists of universities occupying different positions in the consolidated ranking of higher education institutions of Ukraine.

- The most authoritative among experts and mass media national rankings of educational institutions of Ukraine were used as initial data for development of the consolidated rating of Ukrainian higher education institutions: The ranking "Top-200 Ukraine"⁶ is an independent academic ranking of higher education institutions of Ukraine, developed by the Center for International Projects "Euroeducation"⁷ in partnership with the international group of experts IREG Observatory on Academic Ranking and Excellence⁸;
- The ranking "Scopus"⁹ is the ranking compiled by Osvita.ua based on the results of scientometric monitoring of the subjects of scientific and publishing activity of Ukraine according to the indicators of the SciVerse Scopus database in April 2021);
- The ranking " External Evaluation Score for a contract"¹⁰ – the information system "Vstup.OSVITA.UA"¹¹ compiled a ranking of higher education institutions according to the average

⁶ <http://euroosvita.net/index.php/?category=11&id=6556>

⁷ <http://www.euroosvita.net/>

⁸ <http://ireg-observatory.org/en/>

⁹ <http://ru.osvita.ua/vnz/rating/82316/>

¹⁰ <https://ru.osvita.ua/vnz/rating/vstup-osvita/59045/>

¹¹ <https://vstup.osvita.ua/>

score of external examinations of entrants who in 2020 are enrolled in universities at the expense of individuals and legal entities (contract) for the first year on the basis of complete general secondary education in full-time and part-time forms of education. During the compilation of the rating, the data of the introductory campaign of 2020, obtained by the information system "Vstup.OSVITA.UA" from the Unified State Database on Education under the agreement with SE "Inforesource") were used.

Each of the rankings uses different criteria for evaluating universities, so the consolidated ranking of universities allows us to consider the ranking indicators in various ways. In our study, the university's digital index indicates its place in the consolidated ranking.

We analyzed the ratio of different age categories among the TOP-20 scientists at each university. They were determined by the number of articles indexed by the scientometric database Scopus and the h-index. However, the h-index is not the only success criteria of the scientists, the effectiveness of scientific and pedagogical workers is also related to participation in international and project activities, involvement in scientific conferences, seminars, events of various levels, management of scientific schools, training of scientific personnel - graduate students and doctoral students. It should be noted that a high h-index indicates high efficiency in these areas of professional activity. as illustrated by the case of Kherson State University as a typical classical higher education institution. The number of the most productive scientists in terms of the number of articles indexed by the scientometric database Scopus and the h-index was presented as a percentage for greater clarity. Quantitative indicators of the results of publishing activity and the h-index were taken into account, regardless of the author's position in the list of co-authors. The number of the most productive scientists according to these results was presented as a percentage for greater clarity. The numerical index of the university in the table indicates its place in the consolidated ranking.

Table 3

The ratio of age and research and publishing activities of the TOP-20 best scientific and pedagogical workers at HEIs, occupying different positions in the consolidated ranking of higher education institutions of Ukraine

	24-35	36-55	56-75	75+
HEI ₁	15%	35%	40%	10%
HEI ₈	15%	25%	50%	10%
HEI ₁₁	10%	35%	50%	5%
HEI ₁₈	10%	20%	65%	5%
HEI ₄₁	10%	70%	20%	0%
HEI ₄₆	5%	55%	40%	0%
HEI ₆₀	0%	75%	15%	10%
HEI ₈₀	0%	50%	35%	15%

The analysis of the ratio of age and research and publishing activities of the TOP-20 best scientific and pedagogical workers at HEIs, occupying different positions in the consolidated ranking of higher education institutions of Ukraine, allows you to identify certain trends:

1. At higher education institutions, which according to the consolidated rating occupy higher positions and have the best indicators (1-20 position of the consolidated rating), the TOP-20 scientists include representatives of all 4 generations. The ratio of age categories of these institutions indicates about the same percentage of the youngest generation (generation of millennials aged 24 to 35 years) and the oldest (scientific and pedagogical workers of the university aged over 75 years) - from 5 to 15%. At the same time, the younger generation of scientists included in the TOP-20 exceeds the oldest. representatives of the middle age groups (Generation X and Generation Baby Boom) occupy leading positions in the number of scientists among the TOP-20, however at all universities, which occupy 1-20 position in the consolidated ranking, the largest number of representatives of the Baby Boom generation (56-75 years);

2. At universities that occupy the lowest positions in the consolidated ranking (40-80 place), there are no representatives of one of the generations: either the generation of millennials aged 24 to 35 or the generation of research and teaching staff over 75 years among of the university TOP-20 scientists. It should be noted that in this category of educational institutions, the generation X exceeds the number of the Baby Boom generation.

The imbalance in the number of TOP-20 university researchers indicates great risks for future scientific achievements, as the change of generations can lead to a deterioration in the effectiveness of scientific performance of teachers.

3.2. Analysis of the generational balance on the example of KSU

We conducted our study on the example of Kherson State University as a typical domestic higher education institution, which is evidenced, firstly, by its 55th position in the academic ranking of higher educational institutions of Ukraine "Top 200 Ukraine 2020" and 75th position in the consolidated ranking of the universities of Ukraine in 2020. Secondly, it is a classic university that provides studying in almost 100 educational programs at all higher education levels and implements scientific activities in 5 scientific areas. Thirdly, the typicality of the institution is also characterized by the corresponding contingent of applicants (more than 5000) and the number of full-time teachers (more than 300 persons).

According to the theory of generations of American scientists W. Strauss, N. Howe [13], who substantiated the general model of human behavior, which is one repetitive cycle, the human potential of Kherson State University is represented by four generations of scientific and pedagogical workers (Fig. 1).

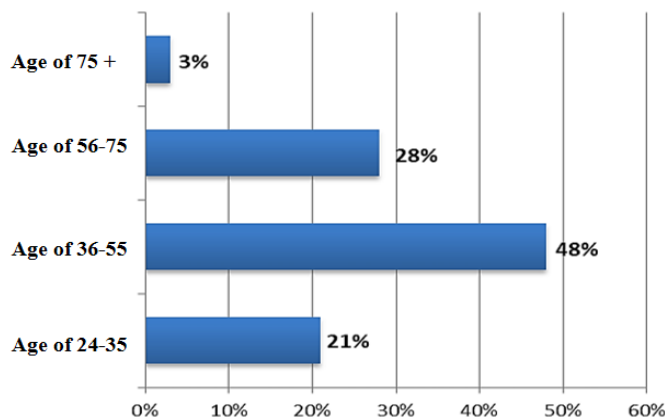


Figure 1: The ratio of generations of the scientific and pedagogical workers of Kherson State University

As can be seen from the diagram, the teachers of generation X aged 36 to 55 (almost 50%) make up the majority of the scientific and pedagogical workers that provide the educational process at the University, the other 50% cover the generation of teachers Baby Boom aged 56 to 75 years (almost 30%) and the generation of millennials aged 24 to 35 years (over 20%). Also a small part of the university scientific and pedagogical workers aged over 75 years (3%).

The general scheme of such distribution of scientific and pedagogical staff of the University is confirmed by the example of nine faculties, where the main part of the personnel potential is made up of teachers aged 36 to 55 (Table 1). For example, the percentage of the scientific and pedagogical workers of generation X at the faculties ranges from the highest (61.4%) at the Faculty of Business and Law to the lowest (41.9%) at the Faculty of Ukrainian and Foreign Philology and Journalism.

Our research proves that the scientific and pedagogical workers of different generations have different performance. In particular, the rating indicators of the scientific and pedagogical staff of the university as individual quantitative (score) indicators of achievement for three years (2017-2019) were determined by the formula [9]:

$$R_{SPW} = \sum_{i=1}^{24} Pi$$

where R_{SPW} – rating of a scientific and pedagogical worker for three years;
 Pi – rating indicator;
 i – the number of rating number from 1 to 24 [9].

The correlation of the rating indicators of university scientific and pedagogical workers with their age indicates that the older generation of teachers have higher performance results (Fig.2). This is quite natural, since the professionalism, productivity of scientific and educational activities, the development of creativity and initiative of a scientific and pedagogical worker depends mainly on the experience gained and the length of service in scientific and pedagogical work: the more experience a teacher has, the higher his rating score.

Table 4

The ratio of age categories of human resources of the university by faculties

University faculties	Age of scientific and pedagogical workers of the university (y %)				
	Age of 18-23	Age of 24-35	Age of 36-55	Age of 56-75	Age of 75+
Faculty of Business and Law	-	21,2	61,4	14	3,5
Faculty of Biology, Geography and Ecology	-	26,5	50	17,6	5,9
Faculty of Computer Science, Physics and Mathematics	-	11,1	44,4	41,7	2,8
Faculty of Culture and Arts	2,7	10,8	48,7	35,1	2,7
Medical Faculty	-	20	48	28	4
Pedagogical Faculty	-	22	44	32	2
Faculty of Psychology, History and Sociology	-	19,3	48,4	32,3	-
Faculty of Ukrainian and Foreign Philology and Journalism	-	27,9	41,9	29	1,2
Faculty of Physical Education and Sports	-	15	55	25	5

Summarizing the statistical data of Table 4, we note that the largest generation gap between the millennials (aged 24 to 35 years) and generation X (aged 36 to 55 years) is observed at the Faculty of Physical Education and Sports and the Faculty of Business and Law, which is more than 40 %. The smallest gap between these generations is at the Faculty of Ukrainian and Foreign Philology and Journalism (14%) and at the Faculty of Education (22%). The average rate of such a gap at the university is 27% in favor of scientific and pedagogical workers of Generation X.

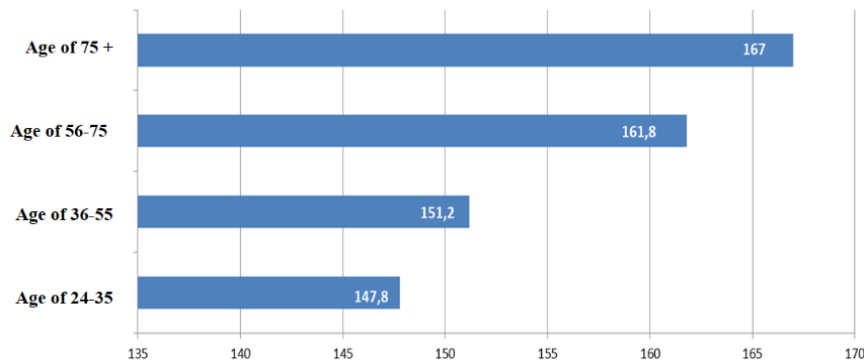


Figure 2: Average rating score of scientific and pedagogical workers of Kherson State University by generations

However, this trend also has partial deviations. In particular, the experience of scientific and pedagogical work does not always guarantee high rating indicators of the teacher. This is evidenced by the results of individual quantitative indicators of achievements of scientific and pedagogical staff of Kherson State University for 2017-2019 [11]. Similar deviations are observed at the level of individual faculties. For example, at the Faculty of Computer Science, Physics and Mathematics, the generation of Millennials, which has the least experience of scientific and pedagogical work, has higher rating scores than all other older generations: Generation X, Generation Baby Boom and Generation 75+ (Fig.3).

This is due to the recruitment system at the University, which begins at the stage of training applicants at the first (bachelor's) and second (master's) levels of higher education. Involvement of students in the implementation of joint projects, such as the distance learning system 'KSU Online'¹², the Kherson State University Virtual Museum¹³, the project 'Stud TV of Kherson State University'¹⁴, distance learning system 'Kherson Virtual University'¹⁵, web-service for feedback "KSU Feedback"¹⁶ is a certain motivation for students to stay and work at the University after studying in a full-time format.

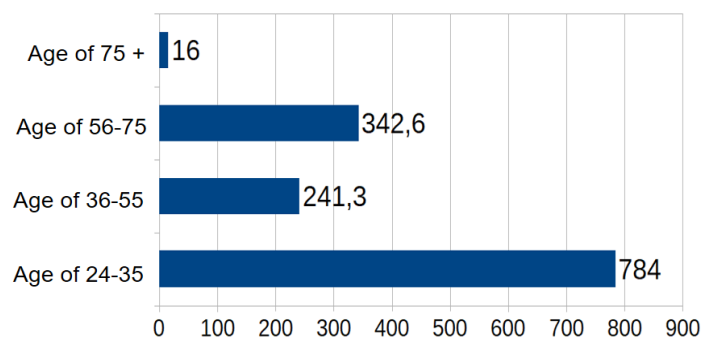


Figure 3: Average rating score of scientific and pedagogical workers of the Faculty of Computer Science, Physics and Mathematics of Kherson State University by generations

¹² <http://ksuonline.kspu.edu/>

¹³ <http://museum.kspu.edu/>

¹⁴ <http://studtv.kspu.edu/>

¹⁵ <http://dls.kherson.ua/dls/Default.aspx>

¹⁶ <http://feedback.ksu.ks.ua/>

There is also a significant gap between the performance of generations of scientific and pedagogical workers at the Faculty of Biology, Geography and Ecology, where the Baby Boom generation has five times lower rating scores than Generation X (Fig. 4).

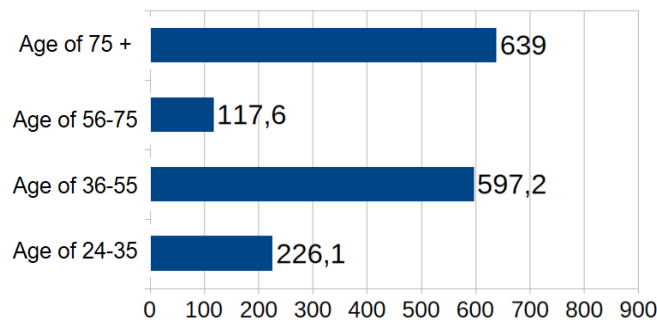


Figure 4: Average rating score of scientific and pedagogical workers of the Faculty of Biology, Geography and Ecology of Kherson State University by generations

This imbalance in generational performance indicates high risks of intergenerational conflict and, accordingly, the cyclical nature of generational change in such faculties in terms of performance may lead to a decrease in the overall result.

3.3. SWOT-analysis of the generational balance of teachers at HEIs

The analysis of the generational balance of universities` teachers, taking into account the efficiency of their performance, made it possible to identify the strengths and opportunities of the generational balance of teachers, as well as weaknesses and threats of imbalance between age groups and their performance. SWOT-analysis was conducted on the basis of qualitative characteristics of the generational balance of teachers in higher education institutions.

Table 5

SWOT analysis of the balance of teachers` generations at higher education institutions

		Positive impact	Negative impact
		Strengths	Weakness
Internal environment		<ul style="list-style-type: none"> • Performance efficiency of teachers; • Formation of the teacher's image; • Formation of the image of the university. 	<ul style="list-style-type: none"> • Demographic imbalance. • Ineffective interaction of teachers of different age categories.
		Opportunities	Treats
External environment		<ul style="list-style-type: none"> • Professional growth of teachers; • Formation of the image of a teacher and a higher education institution; • Increasing the number of university entrants. 	<ul style="list-style-type: none"> • Demographic crisis; • Increased outflow of personnel from the field of science and higher education to other sectors; • The tendency to declining the number of young people in science and the associated general "aging" of teachers.

As the SWOT analysis shows, the strengths of the university teachers generational balance include performance efficiency of teachers, formation of the image of teachers and university. Thus, the study of the ratio of performance and the percentage of departments and faculties on the example of Kherson State University confirms the correlation of performance efficiency and the balance of generations. The formation of the image of teachers and universities is a strong point of the generational balance, since performance improvement has a positive effect on the image of the institution and teachers. The opportunities of the university teachers generational balance, which we have identified, belong to the professional growth of teachers as a result of stimulation to improve their performance increasing the number of university entrants due to higher rating indicators (in particular, in the consolidated ranking of HEIs) as a result of improved performance.

However, demographic imbalance carries risks of deteriorating performance, and the possible ineffective interaction of teachers of different ages is the risk of disturbances in the microclimate in the collective and a negative impact on professional performance. We also identified the following threats generational balance of university teachers: the demographic crisis, as the risk of age imbalance; increased outflow of personnel from the field of science and higher education to other sectors; the tendency to declining the number of young scientist and the associated general "aging" of teachers.

As noted in many studies and confirmed by statistics, there is a tendency to declining the number of young scientists in Ukraine, and as a result, the field of education and science suffers significant staff losses. Thus, we investigated the quantitative indicators of Ukrainian universities that occupy different places in the consolidated ranking (based on the national rankings of educational institutions of Ukraine: "Top-200 Ukraine", "Scopus" and "External Evaluation Score for a contract"). The numerical index of the university in the table indicates its place in the consolidated ranking.

Table 6

Analysis of the number of young scientists in Ukrainian universities

University	Numbers of scientific and pedagogical workers		Numbers of young scientists		Young scientists %	
	2019	2020	2019	2020	2019	2020
HEI ₈	858	790	350	312	41	39
HEI ₄₁	508	480	60	59	12	12
HEI ₄₅	170	203	73	78	43	38
HEI ₇₁	402	386	187	177	47	46
HEI ₇₅	427	362	107	74	25	20

According to the results of the study, the number of young scientists in all universities and, accordingly, their percentage is decreasing. The tendency to declining the number of young people in science and the associated general "aging" of teachers is a real threat to the prospects of future science.

To make effective use of age diversity, it is necessary to be able to involve people of different generations.

To take full advantage of multi-generational performance, any age-related assumptions or stereotypes should be avoided.

When creating project teams of different ages, it is necessary to use the unique strengths of each generation, as well as encourage team members to collaborate and build relationships with each other.

As each generation has its own approach to problem solving, having employees from several generations can be very helpful when it comes to identifying opportunities for innovation and new ways to solve everyday problems.

Each generation is unique, which is a great advantage for the university. The diversity of generations at work opens up opportunities for the training of all teachers. They can teach each other new

approaches and more effective performance. For example, a more technological worker Z can advise how X can cope with exhausting work faster.

Mentoring: Representatives from several generations are an ideal environment for mentoring. Many organizations run mentoring and internal training programs to give employees the opportunity to teach each other. This not only helps employees acquire new skills and information, but also improves their teamwork.

4. Conclusions

According to the analysis of the universities teachers' performance efficiency in different areas in the context of generational balance by using the information and analytical systems, including automated, we can conclude that:

The issue of interaction between generations in higher education and research institutions is insufficiently studied. In particular, in our opinion, the attention should be paid to making effective management decisions. Understanding the characteristics of each generation helps to create comfortable conditions for teachers and increase the level of efficiency of the university.

We have identified a general trend of so-called "aging" of scientific and pedagogical staff. This is influenced by the imbalance of generations in the collectives of higher education institutions, the increased outflow of personnel from science and higher education to other sectors, the tendency to declining the number of young people in science.

Due to the imbalance of generations, there problems in the interaction of different age groups may arise, which in turn will lead to the future reduce of the effectiveness of both scientific and pedagogical staff in particular and the university as a whole.

We studied the dependence of the effectiveness of teachers on the balance of their generations. It was determined that the imbalance is a factor in the deterioration of results, since institutions where there is a lack of the balance, occupy lower positions in the consolidated rating as a whole and in individual ratings.

The imbalance between different age groups of teachers indicates high risks of intergenerational conflict. Performance measurement tools are an important factor for the implementation of educational management in higher education. One of the effective directions in this aspect is the involvement of students of the first (bachelor's) and second (master's) levels of higher education in the development and implementation of internal academic and scientific projects of the university.

In particular, we determine that the focus of final qualification and course research on meeting the needs of higher education institution and its development increases career opportunities for students belonging to Generation Z, in the role of full-time university teachers who can demonstrate high performance.

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