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Level of the information ecosystem of an educational institution and the impact of the digitization process on its development.

Valeriia Loiko *
Andriy Butenko **
Vladyslav Teremetskyi ***
Svitlana Serohina ****
Viktor Sukhomlyn *****

ABSTRACT

The purpose of the article is the formation of methodological recommendations, an algorithm for determining the level of an educational institution's information ecosystem and the identification of the essence of the impact of the digitalization process on its development and transformation. The research methods used are monographic analysis, analysis and synthesis, systemic, economic-mathematical modeling, generalization. It has been substantiated that modern information ecosystems of educational institutions in Ukraine are in the process of formation and the development of their information ecosystem is affected by the process of digitalization. It has been concluded that a person of a new formation is formed due to the improvement and acquisition of new digital skills. Those skills are the basis of professional activity and a vital necessity for a person of a new formation. It has been emphasized that there is a change in the education system – transition from passive learning by listening to active learning by searching and studying information, sharing knowledge and skills under the influence of the digitalization process.

KEYWORDS: educational institution, information, digitization, teaching, digital skills.

* Professor of the Department of Finance and Economic of the Boris Grinchenko Kyiv University, Kyiv, Ukraine. ORCID: <https://orcid.org/0000-0003-3248-1585>. E-mail: v.loiko@kubg.edu.ua

** Associate Professor of the Department of History and Theory of State and Law, European University, Kyiv, Ukraine. ORCID: <https://orcid.org/0000-0002-6946-292X>. E-mail: butenko_an@ukr.net

*** Professor, leading research scientist of the Department of International Private and Comparative Law, Academician F.H. Burchak Scientific Research Institute of Private Law and Entrepreneurship, National Academy of Legal Sciences of Ukraine, Kyiv, Ukraine. ORCID: <https://orcid.org/0000-0002-2667-5167>. E-mail: vladvokat333@ukr.net

**** Professor, Head of the State Building Department, Yaroslav Mudryi National Law University, Kharkiv, Ukraine. ORCID: <https://orcid.org/0000-0002-0107-834X>. E-mail: seregina.kharkiv@gmail.com

***** Associate Professor, Rector of the Academy of Labor, Social Relations and Tourism, Kyiv, Ukraine. ORCID: <https://orcid.org/0000-0001-9558-1968>. E-mail: info@socosvita.kiev.ua

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Nivel del ecosistema de información de una institución educativa y el impacto del proceso de digitalización en su desarrollo

RESUMEN

El propósito del artículo es la formación de recomendaciones metodológicas, un algoritmo para determinar el nivel del ecosistema de información de una institución educativa y la identificación de la esencia del impacto del proceso de digitalización en su desarrollo y transformación. Los métodos de investigación utilizados son análisis monográfico, análisis y síntesis, sistémico, modelación económico-matemática, generalización. Se ha comprobado que los ecosistemas de información modernos de las instituciones educativas en Ucrania están en proceso de formación y el desarrollo de su ecosistema de información se ve afectado por el proceso de digitalización. Se ha concluido que se mejora la formación de una persona debido a la adquisición de nuevas competencias digitales. Esas habilidades son la base de la actividad profesional y una necesidad vital para una persona de nueva formación. Se ha enfatizado que hay un cambio en el sistema educativo: transición del aprendizaje pasivo hacia el aprendizaje activo, buscando y estudiando información, compartiendo conocimientos y habilidades bajo la influencia del proceso de digitalización.

PALABRAS CLAVE: institución educativa, información, digitalización, docencia, competencias digitales.

Introduction

The dynamic information-technological development of the XXI century provides new demands on a person as a self-sufficient individual and a professional capable of an innovative type of thinking, an innovative type of life and competitive professional activity in the innovative society (Teremetskyi et al., 2017).

Analyzing modern points of view on the formation of the information ecoenvironment of educational institutions and the impact of the digitalization process, it is necessary to pay attention to publications focused on the information and digital development of higher education (Kraus et al, 2021a). The digitalization process affects the methods of knowledge transfer, the formation of competencies and practical skills of future experts, the methods of information transfer within educational institutions and external communications. Besides, the digitalization process affects the management of intellectual capital at Universities in the modern knowledge economy (Kichuk et al, 2021).

Some scholars research the issue of information ecosystem's formation in educational institutions. In particular, they pay attention to the fact that the term of "ecosystem" implies

the “splicing” people and information into a single system. The dominant point of view is that the information ecosystem is created and developed by humans and is capable of managing information and building relationships between objects (Pandey and Pattnaik, 2015). Information ecosystems for the most part are understood as systems capable of creating, transmitting and managing information. At the same time, different information ecosystems are formed for different organizations. However, there are common features inherent to all information ecosystems (Ugaz, 2015).

The problem of researching the impact of the digitalization process on the information ecosystems of educational institutions has become especially relevant during the period of quarantine restrictions due to the spread of the acute respiratory disease Covid-19 and other social challenges of the present day. Information ecosystems of educational institutions differ from information ecosystems of other organizations. The entire process of formation of information flows, their transmission, protection and management in educational institutions is carried out with the aim of imparting knowledge, formation of students' professional competences and skills. The digitalization process affects all components of the information ecosystem of educational institutions. The formation of information ecosystems in terms of the pandemic caused by the SARS-CoV-2 coronavirus underwent significant changes and the digitalization process contributed to a significant acceleration of those changes (Zhukova et al, 2021).

Therefore, the purpose of the article is the formation of methodological recommendations, an algorithm for determining the level of an educational institution's information ecosystem and the identification of the essence of the impact of the digitalization process on its development and transformation.

1. Literature review

A small number of scientific works are focused on studying the impact of digitization on the information ecosystems of educational institutions. We believe that this indicates the relevance and necessity of conducting research within this issue. Thus, the scientific article by Kichuk et al. (2021) is focused on studying the role of information while forming intellectual capital in higher educational institutions. The issue of information and digital development of higher education in terms of the innovative economy of Ukraine has been studied in the scientific work by Kraus et al. (2021a). The impact of quarantine restrictions

due to the Covid-19 pandemic on accelerating the informatization of the educational process has been studied in the scientific work by Zhukova and Tymchyk (2021). The article by Satyendra C Pandey and Pinaki Pattnaik (2015) is focused on the formation of the ecosystem of university research in the conditions of digitalization. The model for effective collaborative learning in virtual worlds with intelligent agents has been studied in the scientific work by Ugaz Max Alva Bernuy Augusto (2015). The article by Kraus et al. is focused on the development of the "digital human" mentality as a "genetic code" (2021b). The research works by Aleksandrova et al. are focused on the issues of the role of information in ensuring the quality of education at Universities and increasing the level of the Universities' competitiveness. (2018, 2019). The article by Khoruzha, et al. is focused on the results of the study of the Ukrainian-Polish experience in the formation of digital competence of teachers and digital skills of students in the learning process (2019). Based on the results of the accomplished studies by the indicated scholars, it is advisable to direct scientific research on clarifying the essence of the concept of "information ecosystem of an educational institution" and the impact of the digitalization process on this system.

2. Methods

The authors of this research used the dialectical method of cognition and a number of general scientific special methods of scientific research. Thus, the method of monographic analysis has assisted to clarify those issues that are currently being researched by scholars and are covered in scientific publications. The method of analysis and synthesis made it possible to summarize the information regarding the understanding of the essence of the concept of "information ecosystem of an educational institution" and to form own authors' vision of the essence and composition of the information ecosystem of an educational institution. The application of the system method made it possible to conduct research of the information ecosystem of an educational institution as an open and dynamic system. The method of economic and mathematical modeling was applied to establish the mathematical dependence of the level of the educational institution's information ecosystem on the levels of its components: resource provision, communication policy, corporate culture. The method of generalization made it possible to draw conclusions based on the conducted research.

3. Results and Discussion

3.1. Specific features of understanding the essence of the concept of “information ecosystem of an educational institution”

The term of “ecosystem” is mainly used in the environmental field. Ecosystem in its general form is understood as “a set of living beings who have adapted to living together in a certain environment, forming a single whole with that environment” (Dictionary-handbook on ecology, 2013: 82-83). The definition of “ecosystem” by Chessell, M. means: “A networking community whose members combine their resources on mutually beneficial principles in order to jointly achieve innovative results” (Chessell, M., 2008). Dr. Tapan Munroe, researching the sustainability of the innovation ecosystem, provides the following definition of the concept of ecosystem in his scientific work: “An innovation ecosystem is a dynamic adaptive organism which creates, consumes, and transforms knowledge and ideas into innovative products via the continuous formation of new businesses in a complex matrix of relationships among key elements” (2012).

The essence of the term of “information ecosystem” is that this system combines people and information into a single conglomerate. A person creates, consumes and transmits information in a certain way and through certain technical means. Information in the information system is reproduced, transmitted, accumulated, stored and used by a person in a certain way.

The information ecosystem of an educational institution involves the creation, transmission, accumulation and storage of information with a specific purpose: the effective functioning of an educational institution to fulfill its purpose - providing knowledge, skills and abilities to future experts. A specific feature of the information ecosystem of an educational institution is that this system is able to create a relationship between all subjects through purposeful information management.

The information ecosystem of an educational institution is based on certain values of both society and a specific organization. Such values are usually: social expectations and standards of human behavior in society; understanding of the role and content of information in the organization; expectations of behavior from members of the organization within the regulated corporate culture. Such values for educational institutions, in particular Universities, are regulated by the norms of corporate culture, which are introduced to each new member of the organization.

The functioning of educational institutions assumes that the organization is replenished by hundreds or thousands of new students and a certain number of employees every new academic year. At the same time, there is also a reverse process of graduating of a certain number of education seekers who have already received a diploma. Therefore, the information ecosystem of educational institutions is annually updated according to the factor of users of this system.

Every new student or employee is introduced to the basics of the corporate culture of the educational institution and he / she becomes a full-fledged part of the information ecosystem of this institution. Due to the partial renewal of people as users and fillers of the educational institution's information system, it undergoes changes every year. Therefore, the main specific feature of the information system of an educational institution is its dynamism and annual significant updating of users.

The information ecosystem of an educational institution is an open, dynamic system that is constantly developing. Schematically, the composition of the information system of a higher education institution (University) is presented in fig. 1.

If the system is open, then it has "input" information and "output" information. Laws of Ukraine, resolutions of the Cabinet of Ministers of Ukraine, orders and rulings of the Ministry of Education and Science of Ukraine are the input information for Ukrainian educational institutions. All the information that is public and can be distributed via the Internet or social networks is output information.

All components of the information ecosystem of an educational institution are interconnected, they influence each other and are equal in the formation of the information ecosystem. The last thesis is confirmed by the fact that it is impossible to form a communication policy and corporate culture, and vice versa without resource provision, the communication policy and corporate culture of an educational institution significantly affects the resource component indicating exactly what is needed from technical and technological or personnel support at a certain moment.

The resource support of the information ecosystem of an educational institution consists of technical and technological, organizational and personnel ones. Traditionally, higher educational institutions in Ukraine have better technical and technological support

than institutions of general secondary education. We mean greater equipment with modern computers, software and internal networks of digital communications.

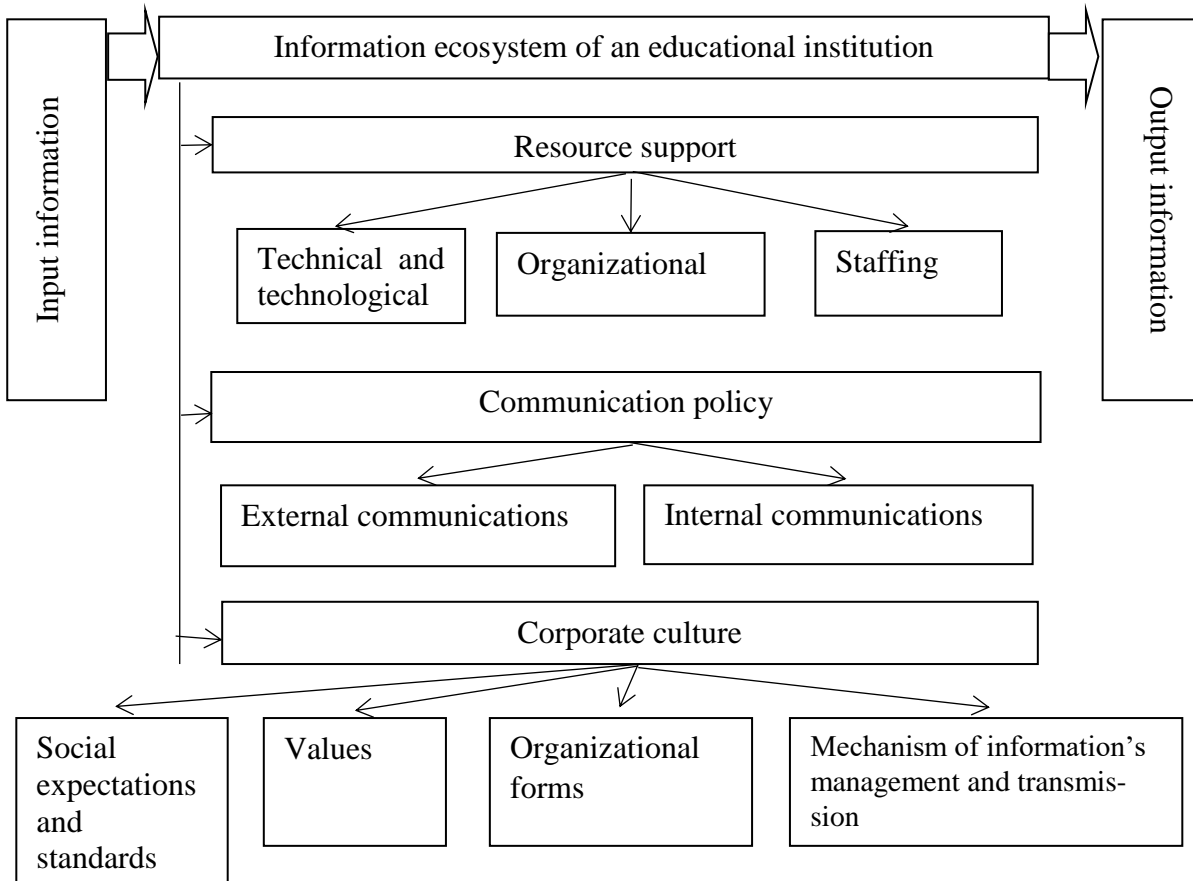


Fig. 1. Composition of the information ecosystem of an educational institution.
 Source: compiled by the authors.

The rapid spread of the pandemic in 2020-2021 has affected all aspects of life and led to economic crisis in many world countries. The Covid-19 coronavirus outbreak highlighted significant gaps in public administration in various spheres of public life (Teremetskyi et al., 2021). Thus, the quarantine restrictions introduced in Ukraine as a result of the Covid-19 pandemic highlighted certain shortcomings of the information ecosystems of higher educational institutions: functional limitation of internal educational systems, insufficient qualifications of employees and personnel, lack of practical management experience and online communication.

The scientific works of the researchers have emphasized that the content of academic disciplines is significantly changed with the mode of online training. However, scientific and

pedagogical employees and teachers are forced to spend their time and take advanced training courses at the same time (Zhukova et al, 2021).

The communication policy of an educational institution is formed in two directions: external and internal communications (Volkova et al, 2019). External communications involve a variety of ways of interacting with external stakeholders: representatives of authorities, representatives of mass media, applicants and their parents, employers and other interested parties. Internal communications involve the process of creating and exchanging information between employees of an educational institution, between teachers and students, between administration and employees and students.

The influence of the digitalization process on the external and internal communications of an educational institution is manifested in the predominance of the online format in communications over the offline format (Loiko et al, 2021). Different communication formats have their advantages and disadvantages. It is obvious that the rapid spread of the online format in both external and internal communications was caused by quarantine restrictions due to the Covid-19 pandemic. The online format in the communication policy of an educational institution has the advantages of significantly greater involvement of different people in the communication process due to the use of new technologies, as well as the possibility of communication at a distance, which significantly saves time and financial costs for transportation.

The online format of education allows those seeking education to accomplish tasks at a convenient time, which makes it possible to work in parallel. The format of online communication requires all communication participants to possess a certain set of digital skills, which employees and teachers of educational institutions can acquire in advanced training courses, and education seekers – in the process of education (Morze et al, 2014, Morze et al, 2020).

The influence of the digitalization process on the communication policy of an educational institution is significant. The transfer of communication to the online format also demanded the improvement of the qualification of employees, updating technical and technological equipment from educational institutions. We mean updating both the computer equipment and the purchase of software or signing up for a subscription to use already developed software resource communication tools. Those measures require

additional funding from educational institutions. General secondary education institutions receive this funding from budget funds, but not in sufficient amounts. Higher educational institutions have the opportunity to use their own earned funds from special funds. They can spend those funds on technical and technological re-equipment or the purchase of the necessary software for online communication. With more financial opportunities, higher educational institutions are more progressive, because they build their own communication strategies on the latest achievements of the digitalization process.

The corporate culture of an educational institution is also an important component of the information ecosystem. The corporate culture of an educational institution has an external manifestation. The external attributes of the corporate culture of an educational institution are manifested in the design of the educational institution's website, symbols, corporate color (if available), traditions, clothing style (if such a style is adopted in the educational institution).

However, corporate culture is not only the external attributes of an educational institution that enable consumers to distinguish one institution from another. Corporate culture is also manifested in internal factors: corporate leadership, which is the basis for forming the mission and basic values of the educational institution, corporate style of communication, support of social norms of behavior, formation of a leadership position among both scientific and pedagogical employees and students. Corporate culture significantly affects the formation of the image of an educational institution (Kolyanko et al, 2020). The digitalization process has a significant impact on the formation of the corporate culture of educational institutions. It is manifested in the presentation of various information in social networks and through the Internet resource with compliance with the requirements regarding the essence and design of this information in a corporate style. Requirements for the compliance with the corporate culture of an educational institution are also presented in student works and academic disciplines, which are placed in the modular environment of the University (Brovko et al, 2018).

3.2. Methodical aspects of the process of diagnosing the information ecosystem of an educational institution

Having presented the information ecosystem of an educational institution as an open system that has various information flows at the entrance and exit and consists of certain

components (resource provision, communication policy and corporate culture), it is appropriate to offer a conceptual algorithm that will allow determining the status of the information system by using an integral indicator “the level of an educational institution’s information ecosystem”. It is possible to determine the quantitative value of this indicator and use this information to make further management decisions according to this algorithm.

The level of an educational institution’s information ecosystem is suggested to be determined by individual components: resource provision, communication policy, corporate culture. The level of an educational institution’s information ecosystem (LEIEs) is represented in the form of the following function (formula 1).

$$LEIEs = f\{[RP];[CP];[CC]\}, \quad (1)$$

where LEIEs – the level of an educational institution’s information ecosystem;

RP – the level of resource support of an educational institution’s information ecosystem;

CP – the level of communication policy of an educational institution;

CC – the level of corporate culture.

The scheme of the calculation algorithm for obtaining the quantitative value of the “level of an educational institution’s information ecosystem” indicator is presented in fig. 2.

The system of single indicators in order to determine the quantitative value of the level of each component of the information ecosystem of an educational institution is developed according to the theory of a balanced system of indicators (Kaplan et al, 1992).

The quantitative value of each single indicator of the components of the level of an educational institution’s information ecosystem is calculated according to certain formulas. Quantitative values of the level of each of the components are calculated as a geometric mean of all single indicators that are selected to calculate the level of this component.

The comprehensive assessment of the integral indicator of the level of an educational institution’s information ecosystem for each individual indicator is considered as the geometric mean for all d_j indicators and is calculated according to formula (2):

$$K_\gamma = \sqrt[n]{\prod_{j=1}^n d_j}. \quad (2)$$

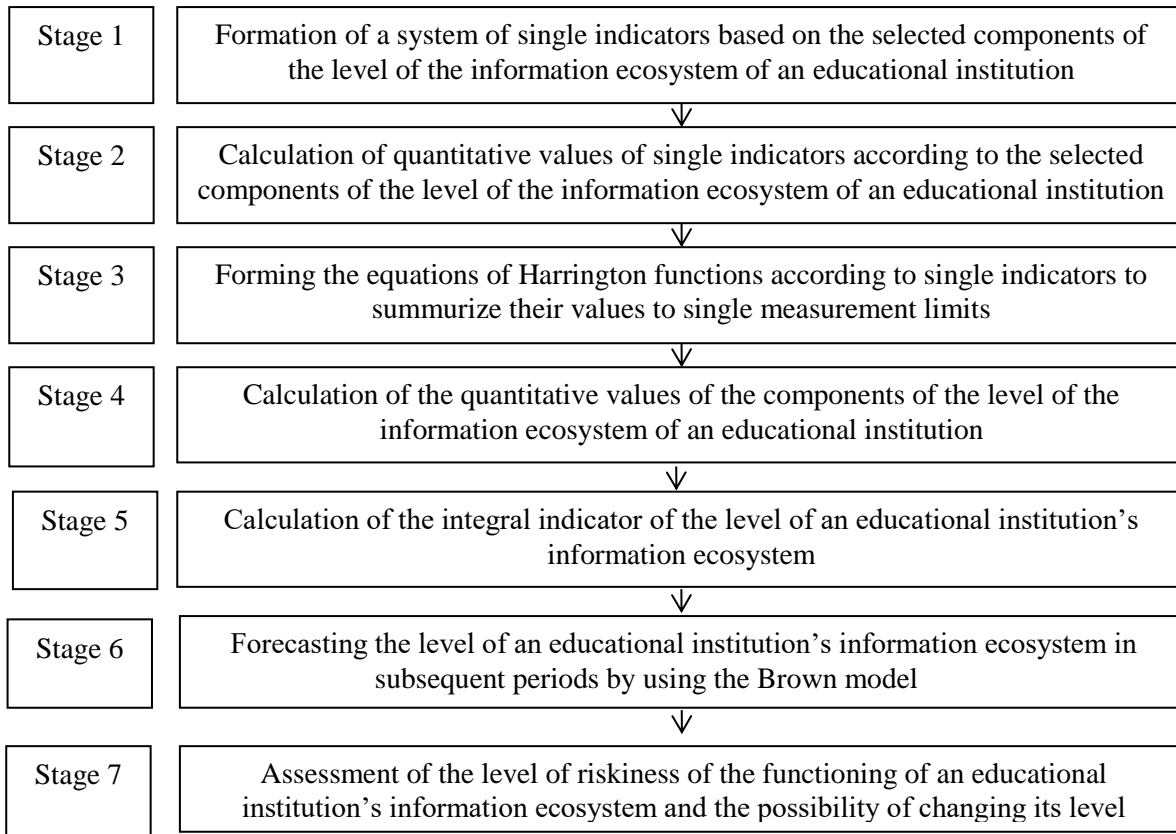


Fig. 2. Scheme of the calculation algorithm for obtaining the quantitative value of the indicator of “level of the information ecosystem of an educational institution”.

Source: compiled by the authors.

The scale offered in the theory of E. Harrington (Harrington, 1965) is used to determine the qualitative status of the level of an educational institution's information ecosystem (Table 1).

Table 1. Ranges of the value of the integral index of the level of an educational institution's information ecosystem according to E. Harrington theory

Range of values	Characteristics of evaluation
0.00 – 0.20	unsatisfactory level of the educational institution's information ecosystem
0.21 – 0.36	low level of the educational institution's information ecosystem
0.37 – 0.62	satisfactory level of the educational institution's information ecosystem
0.63 – 0.79	good level of the educational institution's information ecosystem
0.80 – 1.00	excellent level of the educational institution's information ecosystem

According to the obtained results of the calculation of the integral indicator of the level of the information ecosystem of an educational institution, it is possible to obtain results in a qualitative dimension and to conclude whether the current level of the information ecosystem of the University is sufficient for further management decisions.

3.3. Results of calculations and conceptualization of the algorithm for forecasting changes in the information ecosystem of an educational institution under the influence of the digitalization process

The system of single indicators is formed at the first stage of calculating the quantitative value of the level of an educational institution's information ecosystem for the specified components: resource provision, communication policy and corporate culture. This system includes those indicators that can be calculated by formulas and a quantitative value can be obtained. Indicators that can be evaluated only in a qualitative dimension can be added to the system of single indicators in the form of expert evaluation results. The system of indicators suggested by the authors for determining the quantitative level of an educational institution's information ecosystem is shown in the table. 2.

Table 2. System of indices of an educational institution's information ecosystem

Integral index	Group indices	Single indices
The level of an educational institution's information ecosystem	1. The level of resource support of an educational institution's information ecosystem	1.1. The coefficient of updating technical means of reproduction and transmission of information in an educational institution. 1.2. The coefficient of updating technological means of reproduction and transmission of information in an educational institution. 1.3. The efficiency of using working time in the processes of reproduction and transmission of information in an educational institution. 1.4. The level of experts' availability in the processes of reproduction and transmission of information in an educational institution.
	2. The level of communication policy of an educational institution	2.1. Efficiency coefficient of external communications. 2.2. Efficiency coefficient of internal communications.
	3. The level of corporate culture	3.1. Index of the compliance with the basic provisions of corporate culture by employees of an educational institution. 3.2. Index of the compliance with the basic provisions of corporate culture by students of an educational institution.

Source: Compiled by authors

Formulas for calculating individual single indicators and recommended desired values of their quantitative measurement are offered by the authors (Table 3).

Table 3. Formulas and recommended and regulatory values for the calculation of individual indices of an educational institution's information ecosystem

Index	Formula for calculation	Name	Recommended regulatory values
1.1. The coefficient of renewal of technical means of reproduction and transmission of information in an educational institution.	$CRTHM = \frac{NINTM}{TNTM}$	NINTM – the number of introduced new technical means for generating and transmitting information during the studied period of time (month, quarter, year); TNTM – the total number of technical means for creating and transmitting information in an educational institution	≥0.5-1.0
1.2. The coefficient of renewal of technological means of reproduction and transmission of information in an educational institution.	$CRTLM = \frac{NINTLM}{TNTLM}$	NINTLM – the number of introduced new technologies for generating and transmitting information during the studied period of time (month, quarter, year); TNTLM is the total number of technologies for creating and transmitting information in an educational institution	≥0.5
1.3. The efficiency of using working time in the processes of reproduction and transmission of information in an educational institution.	$EUWT = \frac{NHWT}{TNNHWT}$	NHWT – the number of hours of working time spent on reproduction and transmission of information for the studied period (month, quarter, year); TNNHWT – the total normative number of hours of working time for the studied period (month, quarter, year);	≥0.5-1.0
1.4. The level of experts' availability in the processes of reproduction and transmission of information in an educational institution.	$LPS = \frac{NSAW}{NSNW}$	NSAW – the number of experts who actually work on the processes of reproduction and transmission of information in an educational institution;	≥0.8-1.0

		NSNW – the number of experts who are expected to work on the processes of reproduction and transmission of information according to the regular schedule of an educational institution.	
2.1. Efficiency coefficient of external communications.	$ECEC = \frac{NECC}{TNOC}$	NECC – the number of external communications that continued during the studied period (month, quarter, year); TNOC – the total number of officially confirmed external communications for the studied period (month, quarter, year);	→ 1.0
2.2. Efficiency coefficient of internal communications.	$ECEIC = \frac{SQRI}{TAI}$	SQRI – speed and quality of production, transfer and obtaining information within the organization (assessed by expert evaluations in points); TAI – the total amount of information for the studied period, which is taken as 1.0 in expert assessments.	→ 1.0
3.1. Index of the compliance with the basic provisions of corporate culture by employees of an educational institution.	$ICCC = \frac{NEFSCC}{TNE}$	NEFSCC – the number of employees of an educational institution who fully support the standards of corporate culture; TNE – the total number of employees of an educational institution.	→ 1.0
3.2. Index of the compliance with the basic provisions of corporate culture by students of an educational institution.	$ICSCC = \frac{NGFSCC}{TNG}$	NGFSCC – the number of students of an educational institution who fully support the standards of corporate culture; TNG – the total number of students of an educational institution.	→ 1.0

Source: Compiled by authors

The results of calculations of the integral index of the level of an educational institution's information ecosystem should be compared with the range of values according to D. Harrington theory (Harrington, 1965) (table 4).

Table 4. Results of calculations of the levels of functional components and the integral index of the level of the information ecosystem of an educational institution

Period	Integral index of the level of the information ecosystem of an educational institution	Interval by D. Harrington theory	The level of the information ecosystem of an educational institution
Educational institution A			
2019	0.436	0.37–0.62	Satisfactory level
2020	0.461	0.37–0.62	Satisfactory level
2021	0,492	0.37–0.62	Satisfactory level
Educational institution B			
2019	0.312	0.21–0.36	Low level
2020	0.365	0.37–0.62	Satisfactory level
2021	0.398	0.37–0.62	Satisfactory level
Educational institution C			
2019	0.502	0.37–0.62	Satisfactory level
2020	0.564	0.37–0.62	Satisfactory level
2021	0.638	0.63–0.79	Good level
Educational institution D			
2019	0.414	0.37–0.62	Satisfactory level
2020	0.436	0.37–0.62	Satisfactory level
2021	0.478	0.37–0.62	Satisfactory level
Educational institution J			
2019	0.469	0.37–0.62	Satisfactory level
2020	0.527	0.37–0.62	Satisfactory level
2021	0.572	0.37–0.62	Satisfactory level

Source: Compiled by authors

According to the conducted calculations of the level of the information ecosystem of the five Ukrainian educational institutions selected for the research, all educational institutions had a sufficient level of the information ecosystem. It can be considered positive

that the dynamic trends in the development of the level of information ecosystems of educational institutions tend to grow over the years. Educational institution S received the highest level in 2021 out of all educational institutions that were researched, “Good level”.

Conclusions

It can be concluded that the information ecosystems of educational institutions are being developed. The integral indicator of “level of an educational institution’s information ecosystem” reflects the situation that has been already developed in a certain educational institution. To make a forecast for changing this indicator in future periods, it is necessary to pay attention to the methods of forecasting and assessing the risks and threats. Certain methods and tools are used for forecasting and assessing the risks. It is advisable to combine all the calculations that are necessary for diagnosing and forecasting the level of the educational institution’s information ecosystem into a single complex with the use of computer technology and a database storage system. An expert system can be such a system, which will allow both to accumulate data, calculation results, forecast data and to provide expert conclusions regarding the further development of the information ecosystem of a particular educational institution.

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