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FACTORS AND METHODS FOR ASSESSING THE VALUE OF DIGITAL INTELLECTUAL ASSETS IN THE DIGITAL UNIVERSITY

ФАКТОРИ ТА МЕТОДИ ОЦІНКИ ВАРТОСТІ ЦИФРОВИХ ІНТЕЛЕКТУАЛЬНИХ АКТИВІВ У ЦИФРОВОМУ УНІВЕРСИТЕТІ

Abstract. *The digital transformation of higher education is accompanied by the emergence of new intangible resources – platforms, data, algorithms, digital teacher avatars, and educational services – which highlights the problem of their valuation. Traditional approaches to intangible assets are insufficient, as they do not account for the specific determinants of the university environment.* ***The purpose of the article*** *is to identify the factors shaping the value of universities' digital intellectual assets and to substantiate the applicability of the income, market, and cost approaches to their valuation. The study is based on a systemic approach, methods of analysis and synthesis, and comparative analysis of practices. External and internal, traditional and specific value factors are systematized, among which the key ones are scalability, network effects, interoperability of standards, data legal purity, and demonstrable educational and scientific effect.* ***The results*** *showed that the income approach is fundamental, as it most fully captures cash flows from licensing, cost savings, and data monetization. The market approach is useful when market analogues exist, while the cost approach has limited relevance. An evaluation toolkit is proposed, including discounted cash flows, the relief-from-royalty method, real options, scenario and stochastic analysis. It is concluded that universities require their own system for valuing digital intellectual assets, ensuring transparency, accountability, and reproducibility of management decisions.*

Keywords: *digital intellectual assets, digital university, digitalization, investment decisions, assessment methods.*

Анотація. Вступ. *Проблема оцінювання цифрових інтелектуальних активів університетів є актуальною у зв'язку з цифровою трансформацією вищої освіти, яка супроводжується появою нових форм нематеріальних ресурсів – платформ, даних, алгоритмів, цифрових аватарів викладачів, освітніх сервісів. Традиційні підходи до оцінювання активів виявляються недостатніми, оскільки не враховують специфічні детермінанти вартості в умовах освітнього середовища.* ***Метою статті*** *є визначення ключових факторів формування вартості цифрових інтелектуальних активів університету та обґрунтування придатності основних підходів і методів їх оцінювання для забезпечення обґрунтованих управлінських та інвестиційних рішень.* ***Методи.*** *У дослідженні застосовано системний і структурно-функціональний підходи, методи аналізу й синтезу, а також порівняльний аналіз міжнародних практик оцінювання нематеріальних активів. Авторська систематизація факторів базується на поділі на зовнішні та внутрішні, традиційні й спеціальні детермінанти, з урахуванням освітньо-наукової специфіки університетського середовища.* ***Результати.*** *Встановлено, що для цифрових інтелектуальних активів визначальними є спеціальні фактори – інтероперабельність, масштабованість, мережеві ефекти, правова чистота даних і прав інтелектуальної власності, доказовий освітній і науковий ефект. Сформовано матрицю можливості застосування доходного, порівняльного і витратного підходів для різних видів активів, яка демонструє домінування доходного підходу. Запропоновано методичний інструментарій: дисконтовані грошові потоки з урахуванням ефектів економії, метод звільнення від роялті, реальні опціони для умов високої невизначеності, сценарний і стохастичний аналіз для оцінювання ризиків.* ***Висновки.*** *Проведене дослідження дозволяє стверджувати, що університети потребують власної методичної системи оцінювання цифрових інтелектуальних активів. Запропонована систематизація факторів і матриця методів можуть слугувати практичним орієнтиром для управлінців у сфері інвестування, обліку, ризик-менеджменту й забезпечення прозорості та відтворюваності оцінювальних процедур. Подальші дослідження мають бути спрямовані на розроблення уніфікованих показників педагогічної та наукової результативності, що транслюються у вартісні метрики.*

Ключові слова: *цифрові інтелектуальні активи, цифровий університет, діджиталізація, інвестиційні рішення, методи оцінки.*

Statement of the problem. The vast majority of existing approaches to the valuation of intangible assets are designed to meet the needs of commercial technology companies and are based primarily on financial metrics and classic assessment approaches – income, comparative, and cost. This approach is insufficient for the educational environment, as digital intellectual assets have specific sources of benefits and risks: network effects, interoperability of standards, legal clarity of data and intellectual property rights, maturity of cybersecurity processes, pedagogical and scientific effectiveness, scalability and upgradeability, etc.

In practice, higher education institutions lack consistent rules for identifying, inventorying, capitalizing, and reassessing such assets; the market for analogues has limited transparency, licensing models are heterogeneous, and the connection between educational and scientific effects and cash flows is methodologically inconsistent. As a result, management and investment decisions regarding digital intellectual assets are made under conditions of high uncertainty, which is exacerbated by the risks of technological obsolescence, intellectual property rights violations, and gaps in data governance.

The existing scientific and practical base pays insufficient attention to the integration of specific cost determinants into a fair assessment framework for universities, in particular, the translation of pedagogical and scientific results into value-based indicators and the calibration of discount rates taking into account the risk profile. Therefore, it is important to develop a methodologically consistent system of assessment factors and procedures that combines classical approaches with industry-specific metrics of data quality, interoperability, security, and evidence of educational and scientific effects, and ensures the reproducibility and accountability of decisions in a digital university.

Analysis of recent research and publications. The issue of accounting for globalization risks in the formation and implementation of international investment strategies is considered in the work of C. Safarli et al., which focuses on the impact of external challenges on strategic decision-making and the assessment of intangible resources [1].

The problematics of modernizing enterprises with the help of automated systems are highlighted in the research by P.V. Huk and O.V. Skliarenko, which substantiates the economic feasibility of digital innovations [2]. In this regard, Ya.O. Kolodinska, O.V. Skliarenko, and O.Yu. Nikolaievskyi analyzes the practical aspects of developing business ideas using digital services, emphasizing their potential for creating new assets [3].

In the field of education, G. Kortemeyer, N. Dittmann-Domenichini, and C. Merki study the differences between attending lectures in traditional, hybrid, and online formats, which allows assessing educational outcomes and the effectiveness of relevant digital tools [4]. At the same time, O.O. Khomenko, M.V. Paustovska, and I.A. Onyshchuk analyzes the impact of interactive technologies on the learning process and development of higher education students, highlighting the effects that can be transformed into value-based indicators [5].

The purpose of the article is to identify the factors in the value formation of a university's digital intellectual assets and to establish the applicability of the main approaches and methods for their assessment in order to ensure sound management and investment decisions, based on modern concepts of digital transformation.

Presentation of the main research material. As we have already noted, the main trend in recent years in the development of the economic and educational space has been digital transformation. Under the influence of structural changes in the global economy and the institutional and regulatory environment, traditional organizational models have revealed vulnerabilities in terms of their effectiveness. Higher education institutions, as socio-technological institutions, are actively seeking alternative formats for managing educational, scientific, and administrative processes, taking advantage of the digital environment. On the one hand, digitalization accelerates the development of technologies that improve the effectiveness of an institution's interaction with key stakeholders. On the other hand, it enables the creation of unique digital products and services (learning platforms, data arrays, software solutions, teachers' digital avatars, content, and algorithms) that are in demand by society and the economy. Under these conditions, the identification, accounting, and substantiated assessment of the value of a university's digital intellectual assets becomes strategically important as a basis for investment decisions, risk management, accountability, and measurement of created value.

As with any object of valuation, external factors play a significant role in determining the value of digital intellectual assets: the state of the macroeconomy, political stability, the quality of the legislative framework, regulations in the field of intellectual property and data protection, price dynamics in relevant markets, the availability of financing for innovation, etc. [2;6]. At the same time, specific determinants inherent in digital assets are decisive for the DIA: the level of development of information technologies, the qualifications and professional level of developers/owners/users, interoperability standards, security and maturity of maintenance processes, scalability, network effects, as well as pedagogical and scientific effectiveness in the case of academic application.

For clarity, let us summarize the specific factors in the value formation of certain types of DIA, taking into account the context of a digital university, in Table 1.

Thus, summarizing the above list of factors influencing the value of DIA, it is advisable to group them according to two characteristics: external and internal to the asset; as well as traditional (analysis of which is carried out in relation to any objects of valuation) and special (analysis of which is relevant only for DIA) factors. Of course, this classification is not new, since there are specific factors that influence the value formation of any object of valuation. At the same time, in this work, we systematize for the first time the specific factors in the value formation of digital intellectual assets in the context of a digital university, which clarifies the subject of valuation and increases the validity of management decisions regarding investment, accounting, and risk management.

Let us move on to the problem of using existing approaches and methods of value assessment in relation to digital assets, including intellectual ones. In practice, three basic approaches are used for assessment: comparative, income, and cost [7, p. 31]. The applicability of a particular approach is determined by the economic essence of the asset and its usefulness to the owner/user within the object. For the digital university ecosystem, the following classification is appropriate (Table 2).

The data in Table 3 show that the income approach is the basic one, since the usefulness – and therefore the value – of most digital assets is measured by the amount of income/savings they generate (royalties, license fees, data monetization, productivity gains). For financial reporting and transaction purposes, the following valuation bases are used: fair value, fair market value, and, in integration cases, synergistic value. The identification of rights to digital assets occurs through license agreements, tokens/smart contracts, registry entries, and network identifiers (URI).

Table 1

Specific factors in the value formation of certain types of digital intellectual assets in a digital university

No i/o	Name of the DIA	Key factors in the value formation
1	Neurotechnology and artificial intelligence (AI/ML models, teachers' digital avatars)	Learning ability; generalization limits; quality and volume of training data; reproducibility of results; interpretability; effect on educational outcomes; scalability.
2	Distributed ledger technology (DLT) systems for digital certificates/microcredits	Market quotations/prices on related transaction markets; network reliability and throughput; validation/maintenance costs; investment potential of the solution through increased trust in qualification verification.
3	Innovative technologies for the production of educational services	Savings on "measurement" operations (assessment, quality analytics); optimization of communication and information logistics; optimization of data processing and reduction of production costs; competitive advantages in the educational services market; costs associated with digitization.
4	Robotics and sensor equipment	Level of innovation; share of digital components in the value; positive/negative externalities from use (safety, ecology); direct and indirect costs of creation; additional user benefits/income (educational, scientific, grant effects).
5	Virtual and augmented reality	Optimization of process modeling; completeness and accuracy of digital reconstruction; creation of competitive advantages due to the "immanence" of the model to the educational environment; effect on the safety and accessibility of practices.
6	Learning management platforms (LMS/LXP), learning analytics (LA)	Number of active users; network effects; depth of personalization; interoperability (LTI, xAPI); engagement and success rates; support and update costs; vendor-lock-in risks.
7	Digital content and educational catalogs	Copyright and licensing; uniqueness and updatability; localization; metadata and searchability; reuse between programs; evidence of pedagogical effect.
8	Cloud infrastructure and university API	Reliability and scalability; as-a-service costs; compatibility and downtime; security certifications (ISO/IEC 27001); cost elasticity with respect to demand.

Source: compiled by the author based on [2; 3; 6]

Table 2

Approaches applicable to the valuation of digital (intellectual) assets in a digital university

No i/o	Name of digital asset	The essence and characteristics of asset usefulness	Income	Comparative	Cost
1	Digital rights that arise and are exercised in the information sphere	1) System of property rights, IP, performance of work, and provision of services in digital environments; 2) Usefulness is measured by financial and non-financial benefits; 3) Volume of services received; 4) Effectiveness of the actual/potential outcomes of IA being transferred	Applied partially (DCF; EVA; ROV)	Appropriate in the case of mass-scale objects of valuation	Inappropriate
2	Digital property complex (platforms, licenses, domain names, etc.) and its individual elements	1) Analogy with tangible assets and non-digital intangible assets; 2) Satisfaction of stakeholders' "virtual" needs; 3) Generation of profit/savings	Applied	If there are sufficient relevant analogues	Inappropriate
3	Digital intellectual rights (copyright, related rights, patent rights, license rights)	1) Recording of ownership/usage rights; 2) Ability to generate income while complying with rules and regulations; 3) Combining profitable transactions (licensing, assignment)	Partially – specialized methods (royalty-relief, option approaches, etc.)	Inappropriate	Not applicable
4	Big Data (rights to access/use large data sets)	1) Collection, systematization, and storage of large databases; 2) Expansion of the scope of information search; 3) Optimization of the development of models and forecasts for educational and scientific activities	The object of valuation is the right of access; adjusted DCF is possible	Inappropriate	Not used
5	AI/ML solutions, hardware and software complexes, VR/AR, and other innovative technologies	1) Unique functions that optimize management, training, and research costs; 2) Increased speed of management decision-making, stability, and quality of pedagogical decisions	The valuation methodology is similar to technology valuation (productivity effect, implementation risks)	In isolated cases	Not applicable

Source: compiled by the author based on [2; 9; 10]

Table 3

Approaches applicable to the valuation of digital (intellectual) assets in a digital university

Name of digital asset	Income approach (discounted cash flow method, etc.)	Comparative approach (analog method)	Cost approach (reproduction/replacement)
Digital right (utilitarian digital right)	+	±	–
Digital property (platforms, accounts, domain names, etc.)	+	+	–
Digital assets as part of digital rights	+	±	–
Digital rights as objects of civil rights	+	+ (for license markets)	–
Big data (access/use rights)	+	–	–
Neurotechnology and artificial intelligence	+	±	–
Distributed ledger systems (DLT)	±	–	–
Quantum technologies (R&D stage)	± (option approaches)	–	–
New production technologies (process IT solutions)	+	±	±
Industrial intelligence (industry intelligence, IIoT analytics)	+	–	–
Robotics components (hardware modules with embedded software)	+	+	+
Technological ecosystems/platforms	+	–	–
Virtual and augmented reality technologies	+	±	–

Source: compiled by the author independently

As we can see from Table 3, each approach is implemented through a set of methods that specify its concept, assumptions, and limitations. The evolution of methodological tools is driven by changes in business models and metrics of digital asset usefulness. The classic DCF is being gradually supplemented and sometimes replaced by option approaches that are more suitable for conditions of high uncertainty. The royalty-relief method is increasingly giving way to the cost-saving DCF approach, which more accurately reflects the effects of platforms and learning analytics. Engagement metrics take on a supporting role, while key indicators become those of data monetization, etc. The matrix we have developed can serve as a practical guide for higher education institutions when choosing approaches to investing, accounting, fair value assessment, and risk management of digital intellectual assets.

Conclusions. The conducted research confirmed that the digital intellectual assets of a higher education institution constitute a separate class of intangible resources with a dual nature of value – economic and academic. Their value is formed through the interaction of technological, legal, organizational, and pedagogical factors and must be objectified for the purposes of investment, risk management, accountability, and measurement of created value.

The systematization of factors made it possible to distinguish between external and internal dimensions, as well as traditional and special determinants. For a digital university, the decisive factors are the scalability of solutions, network effects, interoperability of standards, the legal clarity of data and intellectual property rights, the maturity of security processes, the competence of development teams and users, as well as a proven educational and scientific impact. The combination of these factors with the institutional and regulatory environment and market conditions determines the potential for monetization of assets and their fair value.

A generalized matrix of approaches applicable to the valuation of digital (intellectual) assets in a digital university has demonstrated the priority of the income approach, as it most fully reflects cash flows from licensing, cost savings, productivity gains, and other effects of using digital assets. The comparative approach is useful when there are developed markets for comparables and transparent licensing agreements. The cost approach has limited heuristic value, as it does not fully account for network externalities, speed of scaling, and the uniqueness of algorithms and data.

It is advisable to build methodological assessment tools as a combined framework: discounted cash flows with an emphasis on savings effects, the method of exemption from royalties for intellectual property rights, real options for high uncertainty, scenario analysis, and stochastic modeling for the risks of technological renewal and cyber threats. The assessment should be based on the validation of educational and scientific results – indicators of success, engagement, content quality, citation, and grant activity – with the subsequent conversion of these effects into value-based metrics.

Promising areas for further research include standardizing metadata and data quality indicators, developing models for translating educational and scientific effects into cash flows, and testing the proposed matrix of approaches on different types of digital assets. Together, this creates a foundation for improving the quality of management decisions and forming transparent, reproducible practices for assessing the value of a university's digital intellectual assets.

References:

1. Safarli C., Kolach S., Zhyvko M., Volskyi O. & Bobro N. (2024). Considering globalisation risks in the formation and implementation of international investment strategies. *Pakistan Journal of Life and Social Sciences,* no. 22(2), pp. 100284–100293. DOI: https://doi.org/10.57239/PJLSS-2024-22.2.00776

2. Huk P. V. & Skliarenko O. V. (2022). Ekonomichna dotsilnist modernizatsii pidpryiemstv z vykorystanniam avtomatyzovanykh system [Economic feasibility of enterprise modernization using automated systems]. *Ekonomika i upravlinnia – Economics and Management,* no. 2, pp. 103–112. DOI: https://doi.org/10.36919/2312-7812.2.2022.103

3. Kolodinska Ya. O., Skliarenko O. V. & Nikolaievskyi O. Yu. (2022). Praktychni aspekty rozrobky innovatsiinykh biznes-idei z vykorystanniam tsyfrovykh servisiv [Practical aspects of innovative business idea development using digital services]. *Ekonomika i upravlinnia – Economics and Management,* no. 4, pp. 53–60. DOI: https://doi.org/10.36919/2312-7812.4.2022.53

4. Kortemeyer G., Dittmann-Domenichini N. & Merki C. (2025). Attending lectures in person, hybrid or online at a technical university: How do students choose after the pandemic, and what about the outcome? *Discover Education,* no. 4(1), pp. 94. DOI: https://doi.org/10.1007/s44217-025-00500-y

5. Khomenko O. O., Paustovska M. V. & Onyshchuk I. A. (2024). Vplyv interaktyvnykh tekhnolohii na protses navchannia i rozvytok zdobuvachiv vyshchoi osvity [The impact of interactive technologies on the learning process and the development of higher education applicants]. *Naukovi innovatsii ta peredovi tekhnolohii – Scientific Innovations and Advanced Technologies,* no. 5(33), pp. 1222–1231. DOI: https://doi.org/10.52058/2786-5274-2024-5(33)-1222-1231

6. Verina N. & Titko J. (2019). Digital transformation: Conceptual framework. In *Contemporary Issues in Business, Management and Economics Engineering,* pp. 719–727. DOI: https://doi.org/10.3846/cibmee.2019.073

7. Bobro N. (2025). Transforming information architecture in the context of university digitalization. *Journal of Information Technologies in Education,* no. 57, pp. 1–10. DOI: https://doi.org/10.14308/ite000788

8. Kozhyna A. (2022). Reducing poverty, inequality and social exclusion in European countries based on inclusive approaches to economic development. *Economics and Management of the National Economy. The Crisis of National Models of Economic System,* pp. 29–32. DOI: https://doi.org/10.30525/978-9934-26-269-2-7

9. Kubiv S. I., Bobro N. S., Lopushnyak G. S., Lenher Y. I. & Kozhyna A. (2020). Innovative potential in European countries: analytical and legal aspects. *International Journal of Economics and Business Administration,* no. 8(2), pp. 250–264. DOI: https://doi.org/10.35808/ijeba/457

10. Lopuschnyak H. N., Chala O. & Poplavska O. (2021). Socio-economic determinants of the ecosystem of sustainable development of Ukraine. *IOP Conference Series: Earth and Environmental Science,* no. 915(1). DOI: https://doi.org/10.1088/1755-1315/915/1/012019

11. Leiva, L. A., Matera, M., & Schöning, J. (2023). PACMHCI V7, MHCI, September 2023 Editorial. *Proceedings of the ACM on Human-Computer Interaction*, 7(MHCI), no. 191, pp. 1–2. DOI: https://doi.org/10.1145/3604238

Бібліографічний список:

1. Safarli C., Kolach S., Zhyvko M., Volskyi O., Bobro, N. Considering globalisation risks in the formation and implementation of international investment strategies. Pakistan *Journal of Life and Social Sciences.* 2024. No. 22(2), pp. 100284–100293. DOI: https://doi.org/10.57239/PJLSS-2024-22.2.00776

2. Гук П.В., Скляренко О.В. Економічна доцільність модернізації підприємств з використанням автоматизованих систем. *Економіка і управління.* 2022. № 2. с. 103-112. DOI: https://doi.org/10.36919/2312-7812.2.2022.103

3. Колодінська Я.О., Скляренко О.В., Ніколаєвський О.Ю. Практичні аспекти розробки інноваційних бізнес ідей з використанням цифрових сервісів. *Економіка і управління.* 2022. № 4. с. 53–60. DOI: https://doi.org/10.36919/2312-7812.4.2022.53

4. Kortemeyer G., Dittmann-Domenichini N., Merki C. Attending lectures in person, hybrid or online at a technical university: how do students choose after the pandemic, and what about the outcome? *Discover Education.* 2025. № 4(1). С. 94. DOI: https://doi.org/10.1007/s44217-025-00500-y

5. Хоменко О. О., Паустовська М. В., Онищук І.А. Вплив інтерактивних технологій на процес навчання і розвиток здобувачів вищої освіти. *Наукові інновації та передові технології.* 2024. № 5(33). с. 1222–1231. DOI: https://doi.org/10.52058/2786-5274-2024-5(33)-1222-1231

6. Verina N., Titko J. Digital Transformation: Conceptual Framework. In C*ontemporary Issues in Business, Management and Economics Engineering.* 2019. С. 719–727. DOI: https://doi.org/10.3846/cibmee.2019.073

7. Bobro N. Transforming information architecture in the context of university digitalization. *Journal of Information Technologies in Education* (ITE), 2025, № 57. DOI: https://doi.org/10.14308/ite000788

8. Kozhyna A. Reducing Poverty, Inequality and Social Exclusiom in European Countries. Based on Inclusive Approaches to Economic Development. *Economics and Management of The National Economy, The Crisis of National Models of Economic System,* 2022. Pp. 29–32. DOI: https://doi.org/10.30525/978-9934-26-269-2-7

9. Kubiv S.I., Bobro N.S., Lopushnyak G.S., Lenher Y.I., Kozhyna A. Innovative potential in European countries: analytical and legal aspects. I*nternational Journal of Economics and Business Administration,* № 8(2), pp. 250–264. DOI: https://doi.org/10.35808/ijeba/457

10. Lopuschnyak H. N., Chala O., Poplavska O. Socio-economic determinants of the ecosystem of sustainable development of Ukraine. *IOP Conf. Series: Earth and Environmental Science,* 2021. № 1. С.1–9. DOI: https://doi.org/10.1088/1755-1315/915/1/012019

11. Leiva L. A., Matera M., Schöning J. PACMHCI V7, MHCI, September 2023 Editorial. *Proceedings of the ACM on Human-Computer Interaction*, 7 (MHCI), No. 191, pp. 1–2. DOI: https://doi.org/10.1145/3604238

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