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**Viktoriia Prokhorova,**
**Oleksandra Mrykhina,**
**Orest Koleshchuk,**
**Anatoliy Babichev,**
**Iuliia Dudnieva,**
**Krystyna Slastianykova**

# ECONOMIC ASSESSMENT OF INTELLECTUAL AND INNOVATIVE TECHNOLOGIES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

*The object of research is the processes of economic evaluation of intellectual and innovative technologies in the context of sustainable development. The problem of economic evaluation of such technologies is caused by the insufficiency of the current methodological framework, which is substantiated with the use of the VosViewer bibliometric toolkit.*

*The paper identifies the need to implement intellectual and innovative technologies aimed at achieving the goals of sustainable development, as well as their projects, using the example of the "Golden Ducat" Jewelry Company (Ukraine). To substantiate the choice of intellectual and innovative technologies, a methodological approach has been developed based on a system of parameters for expert assessment of the level of intellectualization of technologies (autonomy, adaptability, machine learning, interactivity, integration). The author's approach is proposed to be implemented with the help of a mathematical model based on matrices, using the methods of fuzzy set theory.*

*The practical results of applying the model have shown that the most intellectualized technology is the interactive jewelry design studio, which corresponds to the system of parameters by 73.43 %. Other technologies have lower degrees of compliance: 3D visualization and virtual fitting – 47.16 %, integration of online platforms – 40.50 %, interactive learning services – 34.09 %, and eco-design of products – 23.35 %. The article compares the parameters of intellectualization of technologies with the expected economic performance of a company due to the implementation of these technologies. It is found that the parameters of 'autonomy' and 'machine learning' have the greatest impact on the level of intellectualization. Accordingly, the most effective technologies are an interactive jewelry design studio (ROI – 64.19 %, payback period – 7.3 months) and eco-design of products (ROI – 69.47 %, payback period – 7.2 months). It is found that for a reasonable choice of intellectual and innovative technologies it is important to take into account factors such as market demand, long-term trends and business specifics.*

***Keywords:*** *intellectualization of technologies, intellectual and innovative technologies, business sustainability, assessment of intellectual technologies.*

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## 1. Introduction

Sustainable economic growth involves the efficient use of resources, minimizing negative environmental impacts, and creating conditions for social progress. In this context, intelligent and innovative technologies are becoming a key tool that allows achieving a certain balance between economic benefit, environmental responsibility, and social significance. The development of intelligent and innovative technologies based on artificial intelligence, machine learning, integrated automated systems, etc., opens up new opportunities for increasing productivity, reducing costs, and creating competitive advantages for modern businesses. However, the integration of such technologies requires significant investments and is associated with a high level of risk. In particular, according to *Statista* [1], in 2022, global spending on digital transformation exceeded 1.8 trillion USD, and by 2025 this figure is predicted to reach 2.8 trillion USD. According to *PwC* [2], the implementation of artificial intelligence by 2030 can add more than 15.7 trillion USD to the global economy. The analytical documents of the *McKinsey Global Institute* [3] show that in 2023 the market for automated systems grew by 20 % (345 billion USD). The data presented update the issues of the development of intellectual and innovative technologies and, accordingly, the need for their economic assessment, designed to determine the feasibility and effectiveness of the implementation of such technologies in the long term. At present, there are practically no developments in science and practice that would provide answers to the above-mentioned challenges. The development of intellectual and innovative technologies based on the ideology of sustainable growth mostly occurs as a response to specific market requests, but is practically not mediated by the methodological justification of its implementation. The importance of the economic assessment of intellectual and innovative technologies that contribute to sustainable growth is a key factor in business development. In particular, according to *Deloitte* [4], 76 % of companies worldwide believe that sustainable development is a key factor for the long-term success of their business, and by 2030, it is expected that about 70 % of new business projects will be based on the principles of sustainable development. At the same time, the current economic assessment of such technologies does not allow for the effective integration of environmental and social aspects into business strategies, which is the basis for the formation of sustainable development ecosystems.

Thus, research aimed at the economic assessment of intellectual and innovative technologies in the context of sustainable development and the development of an appropriate methodological framework for

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this are relevant both for enterprises seeking to adapt to the modern market environment and for the state that determines sustainability priorities. This will contribute to the optimization of resources, increase the efficiency of business entities and make a significant contribution to achieving the sustainable development goals set by the UN.

Despite a significant amount of research in the field of innovation, the topic of economic evaluation of intellectual and innovative technologies has not yet received sufficient coverage in scientific works. Methodological solutions regarding the cost and value justification of such technologies have been considered mostly fragmentarily.

From a methodological standpoint, the development of [5] is important, where scientists substantiated the methodology for synthesizing indicators of economic efficiency of outsourcing of information and logistics services of direct and indirect action for the economic assessment of the efficiency of intellectual and innovative activities of an enterprise. The author's method is based on the ratio of indicators that reproduce the benefits obtained through outsourcing. This approach can be partially used to form scenarios for the development of intellectual and innovative technologies, but does not create the desired methodological basis for assessing the economic feasibility of their implementation. In the same context, the publication [6] is of interest, where certain aspects of the economic assessment of intellectual and innovative technologies are considered. In particular, a method for assessing the level of digital culture embedded in innovative technologies has been developed. However, digital culture is only one of the results of the manifestation of the immanent properties of intellectual and innovative technologies, which were not investigated in this work.

Separate methodological components of the economic assessment of intellectual and innovative technologies are substantiated in [7] (within the framework of the approach to pricing *R&D* products) and in [8]. The latter, in particular, deals with the economic assessment of the potential of innovative technologies that contain an intellectual component. In part, the methodological issues raised in the publication [9], in particular, in the context of assessing artificial intelligence and healthcare technologies. These works are important for the subject of the study, namely in terms of predicting the market perception of products manufactured using intellectual and innovative technologies.

The study [10] substantiates the nature of the influence of different types of capital on the efficiency of innovative companies. The issues set out in it are considered on the basis of the IV Industrial Revolution, which caused the rapid progress of intellectual and innovative technologies. Also, from the above-mentioned positions, the paper [11] analyzes the category of intellectual potential and its impact on the socio-economic development of European countries. The publication [12] highlights the current problems of intellectual property development, in particular its financing in small and medium-sized technological enterprises. This is also noted in the work [13], where the authors developed a framework that explores the joint impact of intellectual capital, dynamic capabilities and orientation towards innovative ambidexterity. These developments can become the basis for studying the specifics of the development of intellectual and innovative technologies and changes in consumer behavior caused by modern market developments.

Despite the important contribution of scientists and practitioners to the development of economic theory and methodology of the subject area, they have not sufficiently described the interaction between intellectual and innovative technologies and sustainable development in the field of economic evaluation methodology. In part, this problem is raised in the paper [14], which discusses the determinants of intellectual capital for achieving sustainable growth goals, as well as in [15], which describes the impact of Industry 4.0 on environmental sustainability. In [16], it is analyzed whether elements of intellectual capital can improve business sustainability (the experience of Poland). From such positions, the publication [17] analyzes the development of smart and sustainable technologies in the agricultural sector. However, although the aforementioned works demonstrate the interaction between intellectual and innovative technologies and sustainable development, they do not provide recommendations for its economic evaluation.

In [18] it is confirmed that for the effective use of intellectual and innovative technologies on the basis of sustainable development, each technology should be carefully studied and evaluated, and investments in such technologies should be based on the relevant priorities.

The analysis of scientific sources showed that, despite the relevance and importance of the topic, the economic evaluation of intellectual and innovative technologies remains insufficiently developed. In particular, the issues of methodological substantiation of the influence of the parameters of intellectualization of technologies on the economic feasibility of their implementation are open. At the same time, this is part of the general methodology for assessing the role of technologies in achieving sustainable development goals by business entities, which has also not been developed at present. This creates a significant scientific and practical gap, which determined the subject field of this study.

*The aim of research* is to develop a methodological approach to the economic evaluation of intellectual and innovative technologies in the context of sustainable development. The results obtained, on the one hand, will provide an opportunity to provide a substantiated measurement of the economic feasibility of implementing such technologies on the basis of their impact on the efficiency of the enterprise and compliance with the concepts of sustainable economic growth. On the other hand, they will contribute to a systematic understanding of the factors of intellectualization of modern technologies, which has a practical manifestation in interaction with market actors and the creation of added value. The developed methodological approach is designed to serve as a tool for the methodology of evaluating innovative technologies within the framework of a new paradigm of enterprise competitiveness in the context of sustainable development.

## 2. Materials and Methods

*The object of research* is the processes of economic evaluation of intellectual and innovative technologies in the context of sustainable development.

To achieve the aim of research, hypotheses were formed that outline the framework of the study and provide an opportunity to substantiate scientific and practical recommendations.

*Hypothesis 1.* The level of intellectualization of intellectual and innovative technologies introduced by the enterprise determines the quality of its interaction with customers, which, in turn, leads to an increase in their loyalty and, accordingly, to a strengthening of its market positions.

*Hypothesis 2.* The level of intellectualization of intellectual and innovative technologies introduced by the enterprise determines an increase in the profitability of the enterprise.

The study was conducted on the example of the "Golden Ducat" Jewelry Company, which specializes in the manufacture of high-quality jewelry from precious metals and stones, combining traditional technologies with innovative approaches. In the context of sustainable development, the company actively pursues its goals (Goal 12 – responsible consumption and production), optimizes production processes through intelligent technologies (Goal 9 – innovation and infrastructure) and supports social initiatives (Goal 8 – decent work and economic growth). For the economic evaluation of intellectual and innovative technologies of the company "Golden Ducat" a mathematical model has been developed, which is based on the matrix approach and the use of fuzzy set theory methods. The application of this approach makes it possible to take into account the multifactorial nature of the evaluation process, objectify the results and adapt them to different conditions and criteria.

When developing the model, the Saaty pairwise comparison method was used. This method allows to systematize expert assessments, determine the weighting coefficients of technology parameters and

assess the relative importance of each of them. This approach is especially effective when analyzing complex systems, where parameters have varying degrees of influence on the overall efficiency of technologies.

The matrix approach significantly simplifies multi-iterative calculations, reducing them to an integral indicator of the level of intellectualization. This indicator summarizes numerous parameters that characterize intellectual and innovative technologies, and takes into account their economic efficiency, environmental responsibility and interaction with other systems.

Thanks to the use of fuzzy set theory methods, the author's mathematical model will provide high flexibility and the ability to work in conditions of incomplete or subjective information. This is especially important in the process of strategic planning, where both quantitative and qualitative aspects of assessment are taken into account.

## 3. Results and Discussion

### 3.1. Analysis of the issues of evaluating intellectual and innovative technologies in the context of sustainable development based on the VosViewer bibliometric toolkit

The need to develop a methodological framework for the economic evaluation of intellectual and innovative technologies in the context of sustainable development is due to a significant lack of relevant developments in the subject area, which requires its study in the context of various studies. For this purpose, the bibliographic analytics tool *VosViewer* was used in the work. In particular, a program query for the key term "intellectual and innovative technologies" in publications of the scientometric base *"Scopus"* (in the categories: *"Business, Management and Accounting", "Decision Sciences", "Environmental Science", "Economics, Econometrics and Finance", "Social Sciences", "Arts and Humanities"*) yields the result of 1104 documents. This is a relatively small number, given that intellectual and innovative technologies are a subspecies of innovative ones. Such a number of publications in the subject area indicates insufficient development of the problem.

Based on the obtained data, a network visualization of the term "intellectual and innovative technologies" was carried out. In particular, according to publications in Scopus, such visualization showed seven main clusters (Fig. 1), where it is used most often.

According to Fig. 1, cluster 1 includes 34 contexts, the key of which is patent analysis (red); cluster 2 – 13 contexts, ecology and green economy are highlighted as key (green); cluster 3 – 11, the main context is intellectual property rights (blue); cluster 4 – 10 contexts, where bibliometrics is the leading one (yellow); cluster 5 – 9 contexts, where economy and infrastructure are highlighted (purple); cluster 6 – 7 contexts, among which the context of intellectual property stands out by country (turquoise); cluster 7 – 7 contexts, the key one is innovation (orange). Thus, seven main clusters were identified, demonstrating the multi-vector nature of research in this field, however, a significant part of the contexts is related only to legal, economic or environmental aspects. This, on the one hand, confirms the interdisciplinary nature of the topic, on the other hand, does not provide answers to methodological questions that are based on a combination of the indicated aspects.

Refinement of the query by the key term "intellectual and innovative technologies in the context of sustainable development" yields the result of only 48 documents, which indicates a low level of elaboration of the problems of integrating the principles of sustainable development into intellectual and innovative technologies. Network visualization of this term showed three main clusters with the largest number of its uses (Fig. 2).

According to Fig. 2, cluster 1 covers 13 contexts, the key of which are economics and management (red); cluster 2 – 7 contexts, the main one is digitalization (green); cluster 3 – 6 contexts, among which sustainable development is the most significant (blue).

Thus, according to the results of bibliometric analysis, it is obvious that the topic of intellectual and innovative technologies in the context of sustainable development remains insufficiently developed in the scientific and methodological plane. However, given the importance of such technologies for solving modern challenges related to sustainable development, digitalization, environmental and economic transformations, the methodology for the economic assessment of intellectual and innovative technologies requires an interdisciplinary approach. In particular, this can be implemented by taking as a basis the real practice of an enterprise that implements such technologies.

### 3.2. Research into the need to introduce intellectual and innovative technologies at the enterprise (using the example of the "Golden Ducat" Jewelry Company)

The presented research was implemented using the example of the enterprise "Golden Ducat" Jewelry Company (Ukraine), the main activity of which is the production and sale of jewelry from precious metals and stones. The company is focused on developing exquisite products for the middle and premium segments of the market.


**Fig. 1.** Network visualization of relationships between concepts in the context of the term "intellectual and innovative technologies", by *VosViewer* (in the *"Scopus"* database)

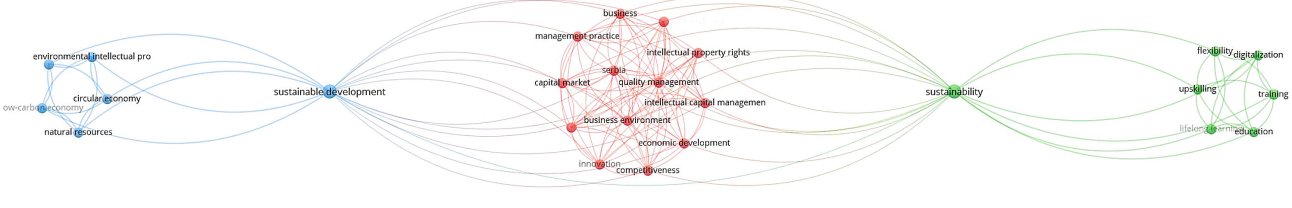


**Fig. 2.** Network visualization of relationships between concepts in the context of the term "intellectual and innovative technologies in the context of sustainable development", by *VosViewer* (in the *"Scopus"* database)

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The progress of "Golden Ducat" and the trends in the development of the jewelry industry in Ukraine and the world have demonstrated the need to transform the company's current approaches to doing business and its communication with consumers. The key problem of the enterprise is the gradual loss of communication with customers against the background of intensifying competitive confrontation. The reason for this is the use of traditional approaches to working with consumers, in contrast to other market operators who actively use intellectual and innovative technologies (mostly in online format) in order to maintain and develop relations with their customers.

The above has led to a decrease in the profitability of the Golden Ducat company. According to the company, the decrease is 6.5–9.3 % annually, over the past three years. At the same time, there is an annual decrease in the size of the average check by 11.57 % in 2024, compared to 2023. An important negative factor is the company's limited presence in the digital space, compared to other operators in the jewelry market. The Golden Ducat company faces difficulties in implementing the principles of sustainable development, in particular due to insufficient integration of environmentally responsible practices into production processes. These and other negative factors have led to a gradual decline in the company's financial sustainability indicators.

The challenges that the "Golden Ducat" Jewelry Company is currently facing in the above context are as follows.

– *Personalization of interaction with consumers.* Insufficient understanding of the needs and interests of certain categories of customers (in particular, offering promotions and assortments aimed at the general public, without taking into account the diversity of the target audience). A study of the opinions of customers of "Golden Ducat" showed that they do not feel an individual approach, which leads to a decrease in their loyalty to the brand. According to the results of a study of trends in the development of the modern market in the context of personalization, the analytical company *Salesforce* found [19] that 65 % of customers expect companies to adapt to their changing needs and preferences (in the business customer segment – 78 %). Also, 61 % of customers believe that most companies treat them as an impersonal quantity, and 56 % of customers often repeat or re-explain information to different representatives of the same company. According to *Marigold* analytics [20], 49 % of consumers feel irritated, and 42 % – disappointed, when they receive messages that do not meet their needs. An analysis conducted by *Accenture* [21] showed that 91 % of consumers are more likely to buy from brands that recognize them as a person and provide relevant offers and recommendations.

– *Integration with digital platforms to improve sales efficiency.* Insufficient integration with digital platforms (online stores, popular social networks, mobile applications, etc.) makes it difficult for "Golden Ducat" to access a significant number of customers who prefer online orders. Digital platforms help analyze customer data to generate individual recommendations, evaluate the effectiveness of marketing campaigns, etc. Competitors that actively use digital channels for sales and promotion adapt faster to new trends and conquer the market, leaving the company in the shadows. According to [19], 73 % of customers expect better interaction based on technological progress, 71 % prefer different channels, depending on the context. Communication with consumers using various digital platforms allows to increase conversion and average check, frequency of purchases. In particular, according to research by the Ukrainian Retailers Association [22], a recommendation system based on digital platforms helps companies increase their revenue by 10–15 % (for example, the largest international online retailer *Amazon* – 35 %).

– *Development of new channels for attracting customers through interactive services and training programs.* Interactive services create a unique customer experience that forms an emotional connection with the brand. However, the "Golden Dukat" company does not implement this to the necessary extent. Ensuring targeted interaction in the subject area on the basis of offering online product design, 3D visualization or virtual fitting, stimulates customers to participate in creating a product. Training programs (courses on jewelry design or lectures on precious metals, help increase customer trust and attract an audience that appreciates the brand's expertise). It should be noted that the younger generation, which makes up a significant segment of the jewelry market, prefers interactive and educational platforms where they can learn new things and be active participants in the process. At the same time, regardless of where the purchase is made, customers strive for the same quality of service. In particular, according to the results of the study [23], 74 % of them expect to be able to do everything online that they can do in person or by phone, 92 % of customers indicated that a positive service experience increases the likelihood of making another purchase, and 71 % made a purchase decision based on the quality of service. 88 % of customers believe that quality service increases the likelihood that they will make a purchase again, and 75 % would recommend a company based on excellent customer service. 80 % of respondents noted that the experience provided by a company is as important as its product. Therefore, ignoring the above will deprive the "Golden Dukat" company of promising consumer segments.

– *Support for the concept of sustainable development in the company's activities.* Modern consumers are increasingly paying attention to the environmental friendliness of products and their manufacturing processes. In the absence of environmental initiatives, the company "Golden Dukat" risks losing customers who value sustainability and responsible production. Failure to take into account environmental aspects in production processes leads to excessive use of resources, increased costs and increased waste, which affects the economic efficiency of the company. According to *Statista* [24], 70 % of consumers are willing to overpay for products manufactured according to the principles of sustainable development. As evidenced by the analytical organization McKinsey [25], businesses that actively integrate the principles of sustainability receive 25–50 % higher customer loyalty. According to *Deloitte* [26], environmentally responsible production can reduce a company's operating costs by 10–15 % due to optimization of resource use.

The above challenges of the "Golden Dukat" company require not only a technical and technological solution, but also a rethinking of the role of the brand in forming an emotional connection with customers, in particular in the current conditions of sustainable economic growth. One of the ways to achieve this is to introduce intelligent tools for conducting business processes aimed at increasing competitiveness and improving the quality of service. These technologies are aimed not only at modernizing business processes, but also at creating a unique consumer experience, which will contribute to an increase in their number and, accordingly, an increase in the size of the average check and overall brand loyalty.

### 3.3. Review of the enterprise's intellectual and innovative technology projects

In order to overcome the above challenges, the management of the "Golden Dukat" Jewelry Company considered the possibility of implementing a number of technologies that would help improve its interaction with customers and optimize production resources, in particular, taking into account the principles of sustainable development. To this end, among the possible technologies, those that are determined by a high level of intellectualization were selected.

The nature and quality of the value parameters of the intellectual property right object invested by the developers in technologies aimed at deepening the company's targeted interaction with customers. A high level of intellectualization of technologies, on the one hand, will allow the "Golden Dukat" company to offer unique solutions and ways of presenting them, which will distinguish it among competitors, and in particular, achieve the principles of sustainable growth. On the other hand, to obtain analytics on customer behavior, which is especially important for interaction with them.

The valuable parameters of intellectual and innovative technology are embodied in the opportunities it creates, such as personalized solutions adapted to the individual needs of customers. Accordingly, this will contribute to the growth of the average check, customer loyalty, the spread of the image of reliability and professionalism of the brand and the sustainability of the company's progress.

Based on the above, an important task is a well-founded choice of intellectual and innovative technologies for the "Golden Dukat" Jewelry Company, from a set of possible ones, for its successful establishment of interaction in the "enterprise – consumer – enterprise" system. The proposed intellectual and innovative technologies to improve the interaction of the "Golden Dukat" company with customers are:

*– interactive jewelry design studio;*
*– 3D visualization and virtual fitting of selected jewelry;*
*– integration of the online platform with biometric data of the company's customers;*
*– eco-design of the company's products;*
*– interactive training services for the company's clients.*

These technologies are developed on the basis of sustainable development goals aimed at finding optimal solutions to economic and environmental problems, smart consumption and technological progress.

The economic assessment of these intellectual and innovative technologies is based on a study of their specifics, which is presented below.

*The interactive jewelry design studio* is a modern intellectual and innovative technology that allows the consumer to create, edit and visualize jewelry in an online format, using integrated digital tools, artificial intelligence and innovative interfaces. The studio provides active user interaction with the program through intuitive interfaces, such as touch screens, virtual and augmented reality devices (*VR, AR*), generative design, etc. The interactive jewelry design studio will allow customers of the Golden Ducat company to fully personalize the jewelry creation process, choosing materials, shapes, colors and decorative elements according to their preferences. Thanks to artificial intelligence and innovative algorithms, the studio will provide automatic recommendations that will help the client create harmonious and aesthetically perfect designs. Real-time 3D visualization makes it possible to see the exact appearance of the future product, which increases confidence in its choice and reduces the likelihood of errors. Integration with digital platforms allows customers to save their designs, share them on social networks or place orders directly through the online interface. The interactive studio can adapt to the needs of a particular user, in particular by configuring the workspace, style templates or proposed algorithms based on the analysis of previous projects. The availability of the online format makes this technology convenient for customers anywhere in the world, providing a unique experience of creating jewelry with maximum comfort.

*3D visualization and virtual fitting of selected jewelry* is a modern technology that opens up the exact appearance of jewelry to customers of the "Golden Ducat" company in real time. They can try on products without leaving their home and understand whether the jewelry meets their expectations. This technology is designed to allow customers to see how the jewelry fits their skin tone, style or other physical parameters. This creates a feeling that the product is made just for them. When customers better understand what a product looks like, the likelihood of post-purchase disappointment is reduced, which reduces the number of returns.

This feature is based on technology that allows each piece of jewelry to be digitized using sophisticated algorithms that take into account even the smallest details and ensure the image is realistic. Artificial intelligence evaluates the user's physical parameters (for example, through a photo or video) and adapts the appearance of the jewelry to their individual characteristics. Virtual fitting is performed using AR. The technology is optimized to work on different platforms, which contributes to its accessibility.

*The integration of the online platform of the "Golden Ducat" company with customer biometric data* is an advanced intellectual and innovative technology that allows to create a unique customer experience, ensuring the accuracy and speed of interaction with the company's services. Thanks to biometric data (fingerprints, face or hand geometry, etc.), customers can receive jewelry that exactly matches their physical characteristics. This guarantees a perfect fit of the product. The use of biometric data reduces the time for selecting product parameters, as the system automatically adapts offers to the individual characteristics of the client. Authorization using biometrics reduces the risk of unauthorized access to the account.

The online platform uses sophisticated algorithms to analyze customer biometric data and convert them into parameters for making jewelry. The system is constantly improving, learning from customer data to offer more accurate personalized solutions. The accuracy of the parameters reduces the risk of errors in production and reduces the level of costs for rework or returns.

*The eco-design of the products of the "Golden Dukat" Jewelry Company* includes the use of certified materials that can be recycled. Information about the origin of materials and the sustainability of production helps to form an emotional connection between the client and the brand. Eco-design reflects the values of conscious consumption, which are becoming increasingly important for modern customers, especially the younger generation.

When implementing a number of intellectually innovative solutions for eco-design and sustainable development, the company will use algorithms to calculate the exact amount of materials needed to make jewelry, minimizing waste. At the same time, "Golden Dukat" will recycle precious metals and stones to create new products without losing their quality. The production processes use modern energy-efficient technologies that reduce the carbon footprint, as well as artificial intelligence to create designs that take into account the minimization of resource use and maximum durability of products. Blockchain algorithms are integrated into the technology to track the supply chain of materials and ensure their sustainable origin. This will allow attracting an eco-conscious audience of consumers who are looking for ethical and ecological brands, and the optimization of resources and the use of secondary materials is designed to reduce the cost of production. An innovative approach to environmental friendliness will distinguish the company from other market operators.

*Interactive customer training services of the "Golden Dukat" company* are aimed at increasing customer awareness of the jewelry business, the processes of creating jewelry and the use of materials. They can combine educational functions and innovative technologies, creating a unique customer experience that contributes to the formation of trust in the brand and increasing loyalty.

Online platforms and mobile applications provide the opportunity to receive knowledge at any convenient time, which corresponds to modern trends in distance learning. Using these services, customers better understand how to choose jewelry, taking into account the characteristics of precious materials, style and trends. The intelligent systems embedded in the technology analyze the preferences and level of knowledge of the client, offering it an individual training plan. The services will position the brand of the "Golden Dukat" company as an expert in its field, which increases its authority among customers. They emphasize the technological and creative component of the brand, distinguishing it among competitors.

A review of intellectual and innovative technology projects for the "Golden Dukat" Jewelry Company showed that the implementation of such solutions will contribute to a significant increase in the level of interaction with customers and, accordingly, the efficiency of business processes and the competitiveness of the company.

### 3.4. Substantiation of the system of parameters for expert assessment of the level of intellectualization of innovative technologies

Based on the fact that the simultaneous implementation of all the above intellectual and innovative technologies is a rather expensive

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task, it is necessary to choose those of them that are optimal for the modern conditions of the enterprise's functioning. For this purpose, a system of parameters has been formed, designed to substantiate the depth and quality of intellectualization of each technology, thanks to which the company will increase the efficiency of interaction with customers. Among the array of existing parameters, key ones have been selected, taken for further economic evaluation, and which are considered in more detail: *autonomy, adaptability, machine learning, interactivity, integration.*

– *Autonomy* ($CONF_1$) is the ability of the system to function without direct human intervention, performing tasks independently, which in particular provides for: making decisions based on data analysis, independent execution of operations, even in cases of variable or complex conditions, minimal dependence on human actions during the execution of routine or repetitive processes. Automation is associated with process autonomy, which includes: monitoring processes, their automatic correction in case of deviations, finding the most effective ways to perform tasks, responding to external factors, etc. The implementation of the autonomy factor in the intellectual and innovative technologies of the "Golden Dukat" company can ensure: the operation of chatbots that provide customer support 24/7, automatic processing of requests for the return or exchange of goods, personalization of offers based on customer data, determination of changes in demand and price dynamics for raw materials or products, substantiation of investment recommendations, etc.

– *Adaptability* ($CONF_2$) is the ability of the system to change its behavior, algorithms or operating parameters, depending on changes in the external or internal environment. It is an important parameter of intellectualization, as it allows systems to: respond to new circumstances, maintain or improve efficiency in changing conditions, learn based on accumulated experience, etc. By analyzing the level of demand, the system can change the volume of orders for goods or redirect them to segments with greater demand. Also, the system can automatically change the settings of the equipment for manufacturing different types of products, according to demand. The application of adaptability characteristics by the "Golden Ducat" company can be especially important in the case of dynamic assortment management. If the demand for a certain product changes (for example, due to seasonality, fashion trends), the system automatically adjusts production or purchases. Based on market analysis, the system changes promotion strategies, focusing on relevant products or regions. In the event of changes in customer ratings or purchasing power, the system offers personalized conditions.

– *Machine learning* ($CONF_3$). The main feature of machine learning is the ability of systems to "learn" based on experience (data), rather than following clear instructions. The system receives and analyzes large amounts of information, its algorithms use data for forecasting purposes. For the "Golden Ducat" company, this characteristic, in particular, will help to identify income, expenses, market risks, fraudulent transactions. By analyzing customer behavior, it will provide personalization of offers, increasing their loyalty. The system can predict equipment maintenance, automatically adjust production plans and detect product defects, optimize inventory management and respond to external changes, determine the target audience, and increase advertising effectiveness.

– *Interactivity* ($CONF_4$) – the system's ability to effectively interact with users or other systems in real time. In the technologies for interacting with customers of the "Golden Ducat" company, interactivity opens up opportunities for improving their service and optimizing business processes. Thanks to interactive technologies, the company can create convenient interfaces for customers, which will allow them to quickly receive the necessary information, place orders or contact support. Chatbots and voice assistants ensure 24/7 service availability, responding to customer requests in real time. Interactivity makes it possible to create personalized dashboards for analyzing income, expenses and financial indicators, which makes resource management convenient and transparent. Interactive platforms contribute to the effective interaction of "Golden Ducat" with customers, offering personalized promotions or recommendations based on their behavior. At the level of production and logistics processes, interactivity contributes to quick access to data on the status of equipment, delivery routes, and warehouse stocks, which ensures a prompt response to changes.

– *Integration* ($CONF_5$) – the ability of the system to seamlessly interact with other technological platforms, tools and processes, creating a single harmonious environment. For "Golden Ducat", this ability is a key condition for the effective functioning of the business, ensuring the coordinated work of all components of the company. Integration of various systems, such as CRM, ERP, analytical platforms and automated production modules, will allow the company to significantly increase productivity and minimize costs. For example, a single platform can automatically update inventory data, optimize production capacities and plan logistics processes in real time. Integration solutions also significantly improve the customer experience. By using data from various sources, "Golden Ducat" can personalize services, quickly respond to customer requests and provide relevant information. In addition, integration contributes to the effective combination of analytics, social media and e-commerce for conducting complex campaigns. Integrated systems provide data from banking systems, accounting and forecasting tools, which contributes to the prompt adoption of strategic decisions. They also increase the level of security, ensuring centralized control of access to information and effective monitoring.

According to the above parameters, it is obvious that all of them will provide sustainable development concepts, promoting a balance between economic efficiency, environmental responsibility and social well-being. In particular, autonomy contributes to the rational use of resources. By automating processes and reducing the need for human intervention, systems minimize energy and material costs, ensuring efficiency and durability. Adaptability allows to quickly respond to changes in the external environment, in particular economic, environmental or social. This reduces the risks of excessive resource consumption and ensures the stability of the company's functioning even in crisis conditions. Machine learning supports sustainable development through the analysis of large volumes of data and accurate forecasting. For example, it helps to optimize production processes, reduce waste, reduce greenhouse gas emissions and create more efficient consumption models. Interactivity leads to an increase in the level of user involvement in sustainable development. Interactive systems can provide users with recommendations on reducing energy consumption or using environmentally friendly products and services. Integration provides a single platform for effective process management, which allows for better coordination of actions within organizations, support environmental initiatives, and promote more rational use of resources through data exchange between different systems.

Despite the value of the above parameters, their use for the economic assessment of the level of intellectualization of technologies has limitations. The main ones are considered.

It is difficult to objectively assess the extent to which a system is autonomous, since some processes may be partially automated, but still require minimal human intervention. The lack of clear metrics makes it difficult to compare the level of autonomy between different systems. The level of adaptability largely depends on the volume, quality, and relevance of data. If the data is incomplete, outdated, or unrepresentative, the system may react incorrectly or inefficiently adapt to changes. The effectiveness of machine learning algorithms depends on large amounts of data and computing resources. For the "Golden Ducat" company, this can be a problematic aspect due to the high cost of creating and maintaining such systems.

Machine learning models can be biased if they are trained on irrelevant data. This leads to erroneous decisions or unfair interpretations of results. Interactivity is limited by the level of users: while interactive systems improve interaction, their effectiveness can be limited by the technical skills of users who do not fully understand how the system works. The integration of systems requires significant resources to configure, combine data, and ensure compatibility between different platforms.

Individual metrics only assess certain aspects of intellectualization, leaving out the integral picture. For example, a high level of interactivity does not always mean a high level of autonomy or adaptability. Assessing the level of intellectualization of technologies does not always directly reflect their impact on business processes. A technology may be technically intelligent, but its implementation may not justify the costs due to market specifics or other factors.

The limitations of these metrics do not reduce their importance, but emphasize the need for a comprehensive approach to assessing the level of intellectualization of technologies. For the "Golden Ducat", it is important to consider these challenges, balancing between the implementation of innovations, efficiency, cost and real impact on the business. The above proves the truth of *hypothesis 1*. Without a doubt, intellectualization can significantly improve operations, convenience and personalization. However, it should be noted that not only customer perception is a determinant of the company's success, other factors also affect the final result: product quality, emotional connection with customers, market conditions, as well as the human factor. In addition, technical failures, high implementation costs or negative perception of new systems by customers can limit the expected effect. Therefore, success depends not only on customer loyalty, which is determined by the level of intellectualization of technologies, but also on a comprehensive approach to its implementation, which takes into account the efficiency of business processes and economic feasibility. Therefore, the proposed system should be suitable for adjustment in terms of individual parameters responsible for certain characteristics of intellectualization.

**3.5. Development of a mathematical model for economic assessment of the level of intellectualization of enterprise technologies**

For economic assessment and selection from a set of optimal intellectual and innovative technologies for further implementation by the "Golden Ducat" Jewelry Company, they must be studied using the parameters proposed above. Given that in such cases the parameters are of different types, degrees of significance are established for them, in particular, using the Saaty pairwise comparison method.

The justification of the author's model for economic assessment of intellectual and innovative technologies is based on methodological developments [27–29]. Using the comparison algorithms proposed by scientists, the basis for expert assessment of the parameters of intellectual and innovative technologies was formed and applied to the situation with the "Golden Ducat" company.

So, based on the Saaty pairwise comparison method, assessments of the advantages of the qualitative characteristics of intellectual and innovative technologies were made within the framework of a nine-point scale. The following scores are determined: "1" – the advantage of element $\alpha_i$ over $\alpha_j$ is absent; "2" – almost unstable; "3" – stable; "4" – almost significant; "5" – significant; "6" – almost unconditional; "7" – unconditional; "8" – almost undeniable; "9" – undeniable. The assessment should be carried out for one element, and the level of dominance of others should be established using logical transitivity: if the *i*-th component prevails over the *j*-th, which, in turn, has a certain advantage over the *k*-th, then the only fair thing is that the *i*-th component prevails over the *k*-th more than the *j*-th. For further evaluation of technologies, it is necessary to determine the minimum estimates of the advantages of other parameters over the *i*-th. The obtained expert assessments are systematized in the form of a square diagonal inverse-symmetric matrix:

$$A=\begin{array}{c} \\ \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_n \end{array}\begin{array}{c} \begin{array}{cccc} \alpha_1 & \alpha_a & \dots & \alpha_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \vdots & \vdots & 1 & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{bmatrix} \end{array}. \quad (1)$$

The choice of a square matrix corresponds to situations when each element is compared with every other in the system, including itself. If the analyzed system has n elements, then the size of the matrix will be $n \times n$. The elements on the main diagonal correspond to the comparison of the element with itself. Usually, they are equal to one, because the influence of the element on itself is always absolute. The property of inverse symmetry means that if $a_{ij}$ is an estimate of the influence of element *i* relative to *j*, then $a_{ji}=1/a_{ij}$ which is consistent with the logic – if element i is twice as important as j ($a_{ij}=2$), then element *j* is half as important as *i* ($a_{ji}=0.5$). This approach is based on the principle of transitivity, which ensures logical consistency in comparisons and allows to identify the consistency of expert reasoning.

The significance parameters ($a_i$) in matrix (1) are determined by the expression:

$$a_i=\frac{1}{a_{1j}+a_{2j}+\ldots+a_{nj}}=\frac{1}{\sum_{i=1}^{n}a_{ij}}=\left(\sum_{i=1}^{n}a_{ij}\right)^{-1}, \quad (2)$$

where $a_{1j}+a_{2j}+\ldots+a_{nj}$ – the sum of the elements of the *j*-th column.

Based on the results of comparisons of intellectual and innovative technology projects of the "Golden Dukat" company, using pairwise comparison matrices, the degree of compliance $\mu_{CONFi}(Q_m)$, is determined, where $Q_m$ is the *m*-th technology variant, and $CONF_i$ is the *i*-th parameter. Comparing intellectual and innovative technologies by each parameter, the required number of pairwise comparison matrices of size $M \times M$ are formed ($M$ is the number of analyzed technologies).

To evaluate intellectual and innovative technologies of the "Golden Dukat" company, let's note the following. The evaluated intellectual and innovative technologies of the company are given by the set:

$$Q=\{Q_1, Q_2, \ldots Q_m, \ldots Q_M\},$$

where $Q_m$ – the *m*-th technology under consideration. The parameters by which technologies are compared are given by the set:

$$CONF\{CONF_1, CONF_2, \ldots CONF_i, \ldots CONF_n\},$$

where $CONF_i$ – the *i*-th parameter (described in detail in section 3.4).

The congruence of the intellectual and innovative technologies of the company "Golden Dukat" to the *i*-th parameter is determined through a fuzzy set specified on the set of *Q*-variants $\mu_{CONFi}(Q_m)$:

$$\widetilde{CONF_i}=\left\{\frac{\mu_{CONF_i}(Q_1)}{Q_1},\frac{\mu_{CONF_i}(Q_2)}{Q_2},\ldots\frac{\mu_{CONF_i}(Q_m)}{Q_m}\right\}. \quad (3)$$

The optimal intellectual and innovative technology according to the system of developed parameters (section 3.4) is the technology that will demonstrate the best results in all parameters.

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Fuzzy solutions $\widetilde{Des}$ are obtained by crossing partial parameters based on the expression:

$$\widetilde{Des}=\widetilde{CONF_1}\cap\widetilde{CONF_2}\cap\ldots\cap\widetilde{CONF_n}=$$
$$=\left\{\frac{\min\limits_{i=\overline{1,n}}\mu_{CONF_i}(Q_1)}{Q_1},\frac{\min\limits_{i=\overline{1,n}}\mu_{CONF_i}(Q_2)}{Q_2},\ldots,\frac{\min\limits_{i=\overline{1,n}}\mu_{CONF_i}(Q_m)}{Q_m}\right\}. \quad (4)$$

According to (4), in the case of equivalence of technology parameters, the best one will be the one with the maximum degree of correspondence:

$$\widetilde{Des}=\arg\max\left(\mu_{Des}(Q_1),\mu_{Des}(Q_2),\ldots,\mu_{Des}(Q_m)\right). \quad (5)$$

In the case of unequal parameters, the degrees of correspondence of the fuzzy set $\widetilde{Des}$ are calculated as follows:

$$\mu_{Des}(Q_m)=\min_{i=\overline{1,n}}(\mu_{CONF_i}(Q_m))^{a^i},m=\overline{1,M}, \quad (6)$$

where $a_i$ determines the weight of the parameter $CONF_i$, $\sum_{i=1}^{n}a_i=1$, which concentrates the fuzzy set $CONF_i$, according to the degree of correspondence of the parameter $CONF_i$.

### 3.6. Determination of the parameters of economic feasibility of intellectual and innovative technologies of the enterprise

Comparing the intellectual and innovative technologies of the "Golden Dukat" Jewelry Company (clause 3.3), using the author's system of parameters (clause 3.4), a number of expert considerations were obtained on the basis of pairwise comparisons of the parameter ($CONF_1$) with others.

The logical expressions used were: indisputable advantage of $CONF_2$ over $CONF_1$; no advantage of $CONF_3$ over $CONF_1$; almost significant $CONF_4$ over $CONF_1$; almost unconditional advantage of $CONF_5$ over $CONF_1$.

Based on the obtained estimates, the scores were determined:

$$a_{12}=9;a_{21}=\frac{1}{9};a_{13}=1;a_{31}=1,a_{14}=4;a_{41}=\frac{1}{4};a_{15}=6;a_{51}=\frac{1}{6}.$$

The data were summarized in a matrix:

$$A=\begin{bmatrix}1 & 9 & 1 & 4 & 6\\ \frac{1}{9} & 1 & \frac{1}{9} & \frac{4}{9} & \frac{6}{9}\\ 1 & 9 & 1 & 4 & 6\\ \frac{1}{4} & \frac{9}{4} & \frac{1}{4} & 1 & \frac{6}{4}\\ \frac{1}{6} & \frac{9}{6} & \frac{1}{6} & \frac{4}{6} & 1\end{bmatrix}. \quad (7)$$

Applying expression (2) to each of the rows of the matrix (7), the significance of the parameters of intellectual and innovative technologies of the "Golden Dukat" company was calculated. The results are summarized in Table 1.

**Table 1**

Significance of parameters of intellectual and innovative technologies of the "Golden Ducat" Jewelry Company

| Parameters | Calculation of significances |
|---|---|
| Autonomy ($CONF_1$) | $a_1=\frac{1}{1+9+1+4+6}=0.048$ |
| Adaptability ($CONF_2$) | $a_2=\frac{1}{\frac{1}{9}+1+\frac{1}{9}+\frac{4}{9}+\frac{6}{9}}=0.428$ |
| Machine learning ($CONF_3$) | $a_3=\frac{1}{1+9+1+4+6}=0.048$ |
| Interactivity ($CONF_4$) | $a_4=\frac{1}{\frac{1}{4}+\frac{9}{4}+\frac{1}{4}+1+\frac{6}{4}}=0.190$ |
| Integration ($CONF_5$) | $a_5=\frac{1}{\frac{1}{6}+\frac{9}{6}+\frac{1}{6}+\frac{4}{6}+1}=0.286$ |

In total, the significance of the parameters will be one: 0.048+0.428+0.048+0.190+0.286=1.

The results of calculating the significance of the parameters showed that the largest share belongs to the parameters "adaptability" – 42.8 % and "integration' – 28.6 %, as well as "interactivity" – 19.0 %. The parameters "autonomy" and "machine learning" have a share of 4.8 %.

The obtained values are the basis for further analysis of the level of intellectualization of technologies proposed by the "Golden Ducat" company for implementation. The calculated results show that the influence of the parameter "adaptability" is significant, compared to other parameters. It is "adaptability" that provides the ability to quickly respond to technology changes in conditions, flexibly adjust processes in accordance with external factors and user requirements. This is a key element in ensuring the efficiency and competitiveness of modern intellectual and innovative technologies.

High values are also characteristic of the "integration" and "interactivity" parameters. Given that "integration" is responsible for the ability of technologies to effectively interact with other systems, combining data, processes and functions into a single intelligent ecosystem, this will allow "Golden Dukat" to ensure the smooth operation of the technology and expand its capabilities. "Interactivity" reflects the company's ability to use this technology to establish convenient and effective interaction with customers.

Regarding the parameters "machine learning" and "autonomy", the obtained values may be subjective due to the limitations of their use in a specific context. For example, "autonomy", although it has the potential to improve the company's efficiency, may be less in demand in conditions where constant control or user participation is required. Similarly, "machine learning", which is relevant only under conditions of sufficient data availability and the company's readiness to implement complex algorithms.

The results of the analysis make it possible to determine priorities for further improvement of technologies aimed at increasing "adaptability", "integration" and "interactivity", while taking into account the possibilities of gradual implementation of autonomous functions and machine learning algorithms.

It should be noted that during the assessment, situations may arise when individual parameters turn out to be only partially relevant for specific conditions of analysis or their use becomes appropriate only in a certain period of time. In such cases, it is necessary to review the system of parameters, making changes to its composition, in accordance with the algorithm proposed by the author's model.

**3.7. Establishing the level of intellectualization of innovative technologies of the enterprise in conditions of sustainable development**

To establish the level of intellectualization of innovative technologies of the "Golden Dukat" company, pairwise comparisons were carried out for each of them, using the author's system of parameters and the Saaty method (Table 2).

**Table 2**

Evaluation of intellectualization of innovative technologies of the "Golden Ducat" Jewelry Company

| Intellectual and innovative technologies | Parameters | Dominance type/value of parameter dominance for pairwise comparison matrix |
|---|---|---|
| Interactive jewelry design studio ($Q_1$) | Autonomy ($CONF_1$) | Stable advantage over $Q_2$ (1/3) |
| | | Almost significant advantage over $Q_3$ (1/4) |
| | | Undeniable advantage over $Q_4$ (1/9) |
| | | Unconditional advantage over $Q_5$ (1/7) |
| 3D visualization and virtual fitting of selected jewelry ($Q_2$) | Adaptability ($CONF_2$) | Almost unstable advantage over $Q_1$ (1/2) |
| | | Almost significant advantage over $Q_3$ (1/4) |
| | | Unconditional advantage over $Q_4$ (1/7) |
| | | Almost unconditional advantage over $Q_5$ (1/6) |
| Integration of online platform with biometric data of company clients ($Q_3$) | Machine learning ($CONF_3$) | Significant advantage over $Q_1$ (1/5) |
| | | Almost unconditional advantage over $Q_2$ (1/6) |
| | | Unconditional advantage over $Q_4$ (1/7) |
| | | Almost undeniable advantage over $Q_5$ (1/8) |
| Eco-design of company products ($Q_4$) | Interactivity ($CONF_4$) | Almost unstable advantage over $Q_1$ (1/2) |
| | | Almost unconditional advantage over $Q_2$ (1/6) |
| | | Almost unconditional advantage over $Q_3$ (1/6) |
| | | Stable advantage over $Q_5$ (1/3) |
| Interactive training services for company clients ($Q_5$) | Integration ($CONF_5$) | Almost unconditional advantage over $Q_1$ (1/6) |
| | | Almost unsustainable advantage over $Q_2$ (1/2) |
| | | Unconditional advantage over $Q_3$ (1/7) |
| | | Almost unsustainable advantage over $Q_4$ (1/2) |

Using the parameters of the advantages of intellectual and innovative technologies, paired comparison matrices were compiled:

$$A(CONF_1)=\begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{4} & \frac{1}{9} & \frac{1}{7} \\ 3 & 1 & \frac{3}{4} & \frac{3}{9} & \frac{3}{7} \\ 4 & \frac{4}{3} & 1 & \frac{4}{9} & \frac{4}{7} \\ 9 & \frac{9}{3} & \frac{9}{4} & 1 & \frac{9}{7} \\ 7 & \frac{7}{3} & \frac{7}{4} & \frac{7}{9} & 1 \end{bmatrix};$$

$$A(CONF_2)=\begin{bmatrix} 1 & \frac{1}{2} & \frac{1}{4} & \frac{1}{7} & \frac{1}{6} \\ 2 & 1 & \frac{2}{4} & \frac{2}{7} & \frac{2}{6} \\ 4 & \frac{4}{2} & 1 & \frac{4}{7} & \frac{4}{6} \\ 7 & \frac{7}{2} & \frac{7}{4} & 1 & \frac{7}{6} \\ 6 & \frac{6}{2} & \frac{6}{4} & \frac{6}{7} & 1 \end{bmatrix};$$

$$A(CONF_3)=\begin{bmatrix} 1 & \frac{1}{5} & \frac{1}{6} & \frac{1}{7} & \frac{1}{8} \\ 5 & 1 & \frac{5}{6} & \frac{5}{7} & \frac{5}{8} \\ 6 & \frac{6}{5} & 1 & \frac{6}{7} & \frac{6}{8} \\ 7 & \frac{7}{5} & \frac{7}{6} & 1 & \frac{7}{8} \\ 8 & \frac{8}{5} & \frac{8}{6} & \frac{8}{7} & 1 \end{bmatrix};$$

$$A(CONF_4)=\begin{bmatrix} 1 & \frac{1}{2} & \frac{1}{6} & \frac{1}{6} & \frac{1}{3} \\ 2 & 1 & \frac{2}{6} & \frac{2}{6} & \frac{2}{3} \\ 6 & \frac{6}{2} & 1 & \frac{6}{6} & \frac{6}{3} \\ 6 & \frac{6}{2} & 1 & 1 & \frac{6}{3} \\ 3 & \frac{3}{2} & \frac{3}{6} & \frac{3}{6} & 1 \end{bmatrix};$$

$$A(CONF_5)=\begin{bmatrix} 1 & \frac{1}{6} & \frac{1}{2} & \frac{1}{7} & \frac{1}{2} \\ 6 & 1 & \frac{6}{2} & \frac{6}{7} & \frac{6}{2} \\ 2 & \frac{2}{6} & 1 & \frac{2}{7} & \frac{2}{2} \\ 7 & \frac{7}{6} & \frac{7}{2} & 1 & \frac{7}{2} \\ 2 & \frac{2}{6} & 1 & \frac{2}{7} & 1 \end{bmatrix}.$$

For the given matrices, the degrees of correspondence of the elements to the fuzzy set $\mu_{CONF_i}(Q_m)$ are established, according to the expression (3). The results of the matrix calculations reflect the values of the membership functions $\mu_{CONF_i}(Q_m)$ of the elements $Q_i$ to the fuzzy set $\widetilde{CONF_i}$.

The fuzzy sets determine the degree of correspondence of the intellectual and innovative technologies of the "Golden Dukat" company ($Q_1$...$Q_5$) to the parameters $CONF_1$...$CONF_5$:

$$\widetilde{CONF_1}=\left\{\frac{0.546}{Q_1},\frac{0.181}{Q_2},\frac{0.136}{Q_3},\frac{0.0605}{Q_4},\frac{0.0776}{Q_5}\right\},$$

$$\widetilde{CONF_2}=\left\{\frac{0.486}{Q_1},\frac{0.243}{Q_2},\frac{0.121}{Q_3},\frac{0.069}{Q_4},\frac{0.0809}{Q_5}\right\},$$

$$\widetilde{CONF_3}=\left\{\frac{0.612}{Q_1},\frac{0.122}{Q_2},\frac{0.1019}{Q_3},\frac{0.0874}{Q_4},\frac{0.076}{Q_5}\right\},$$

$$\widetilde{CONF_4}=\left\{\frac{0.4618}{Q_1},\frac{0.230}{Q_2},\frac{0.0769}{Q_3},\frac{0.0769}{Q_4},\frac{0.154}{Q_5}\right\},$$

$$\widetilde{CONF_5}=\left\{\frac{0.433}{Q_1},\frac{0.0722}{Q_2},\frac{0.216}{Q_3},\frac{0.00618}{Q_4},\frac{0.2165}{Q_5}\right\}.$$

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The obtained results need to be clarified taking into account the significance of the parameters of intellectual and innovative technologies. For this, each of the components of the fuzzy sets is raised to the degree of relative significance of the indicator ($a_1$... $a_6$):

$$\widetilde{CONF}_1^{a_1}=\left\{\left(\frac{0.546}{Q_1}\right)^{0.048},\left(\frac{0.181}{Q_2}\right)^{0.048},\left(\frac{0.136}{Q_3}\right)^{0.048},\left(\frac{0.0605}{Q_4}\right)^{0.048},\left(\frac{0.0776}{Q_5}\right)^{0.048}\right\}=$$
$$=\left\{\frac{0.9714}{Q_1},\frac{0.9212}{Q_2},\frac{0.9087}{Q_3},\frac{0.8740}{Q_4},\frac{0.8845}{Q_5}\right\},$$

$$\widetilde{CONF}_2^{a_2}=\left\{\left(\frac{0.486}{Q_1}\right)^{0.428},\left(\frac{0.243}{Q_2}\right)^{0.428},\left(\frac{0.121}{Q_3}\right)^{0.428},\left(\frac{0.069}{Q_4}\right)^{0.428},\left(\frac{0.0809}{Q_5}\right)^{0.428}\right\}=$$
$$=\left\{\frac{0.7343}{Q_1},\frac{0.5458}{Q_2},\frac{0.4050}{Q_3},\frac{0.3184}{Q_4},\frac{0.3409}{Q_5}\right\},$$

$$\widetilde{CONF}_3^{a_3}=\left\{\left(\frac{0.612}{Q_1}\right)^{0.048},\left(\frac{0.122}{Q_2}\right)^{0.048},\left(\frac{0.1019}{Q_3}\right)^{0.048},\left(\frac{0.0874}{Q_4}\right)^{0.048},\left(\frac{0.076}{Q_5}\right)^{0.048}\right\}=$$
$$=\left\{\frac{0.9767}{Q_1},\frac{0.9039}{Q_2},\frac{0.8962}{Q_3},\frac{0.8896}{Q_4},\frac{0.8836}{Q_5}\right\},$$

$$\widetilde{CONF}_4^{a_4}=\left\{\left(\frac{0.4618}{Q_1}\right)^{0.19},\left(\frac{0.230}{Q_2}\right)^{0.19},\left(\frac{0.0769}{Q_3}\right)^{0.19},\left(\frac{0.0769}{Q_4}\right)^{0.19},\left(\frac{0.154}{Q_5}\right)^{0.19}\right\}=$$
$$=\left\{\frac{0.8635}{Q_1},\frac{0.7564}{Q_2},\frac{0.6142}{Q_3},\frac{0.6142}{Q_4},\frac{0.7008}{Q_5}\right\},$$

$$\widetilde{CONF}_5^{a_5}=\left\{\left(\frac{0.433}{Q_1}\right)^{0.286},\left(\frac{0.0722}{Q_2}\right)^{0.286},\left(\frac{0.216}{Q_3}\right)^{0.286},\left(\frac{0.00618}{Q_4}\right)^{0.286},\left(\frac{0.2165}{Q_5}\right)^{0.286}\right\}=$$
$$=\left\{\frac{0.7871}{Q_1},\frac{0.4716}{Q_2},\frac{0.6451}{Q_3},\frac{0.2335}{Q_4},\frac{0.6456}{Q_5}\right\}.$$

The calculated values of fuzzy sets show to what extent the projects of intellectual and innovative technologies of the "Golden Dukat" company ($Q_1$...$Q_6$) satisfy the parameters of selecting the best of them, according to the nature of intellectualization $CONF_1$...$CONF_5$ (Table 3).

**Table 3**

Values of fuzzy sets by intellectual and innovative technologies of the "Golden Dukat" Jewelry Company

| Intellectual and innovative technologies | Parameters of technology intellectualization | | | | |
|---|---|---|---|---|---|
| | $CONF_1$ | $CONF_2$ | $CONF_3$ | $CONF_4$ | $CONF_5$ |
| Interactive jewelry design studio ($Q_1$) | 0.9714 | 0.7343 | 0.9767 | 0.8635 | 0.7871 |
| 3D visualization and virtual fitting of selected jewelry ($Q_2$) | 0.9212 | 0.5458 | 0.9039 | 0.7564 | 0.4716 |
| Integration of online platform with biometric data of company clients ($Q_3$) | 0.9087 | 0.4050 | 0.8962 | 0.6142 | 0.6451 |
| Eco-design of company products ($Q_4$) | 0.8740 | 0.3184 | 0.8896 | 0.6142 | 0.2335 |
| Interactive training services of company clients ($Q_5$) | 0.8845 | 0.3409 | 0.8836 | 0.7008 | 0.6456 |

Based on the data in Table 3, a petal diagram of the correspondence of the obtained fuzzy sets was formed (Fig. 3). The diagram confirms that the parameters "autonomy" and "machine learning" play one of the most important roles in the processes of intellectualization of technologies. Since they ensure the ability of the company's systems to enhance interaction with customers based on independent data analysis, decision-making and adaptation to changing conditions without the need for constant human intervention. In the diagram, the high values of these parameters are smoothed, unlike the values of other parameters – "adaptability", "interactivity" and integration". However, considering innovative technologies for intellectualization, it is obvious that the most intellectualized solutions are the interactive jewelry design studio and 3D visualization and virtual measurement of selected jewelry, which are characterized by high values of almost all parameters.

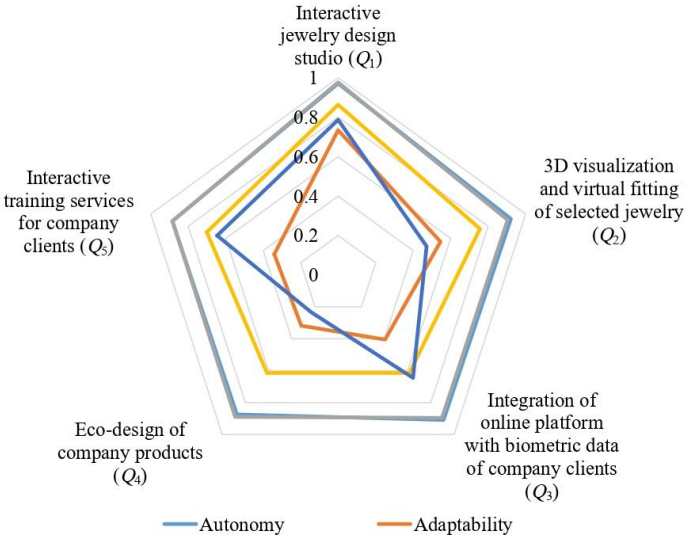


**Fig. 3.** Diagram of comparison of weighted assessments of compliance of intellectual and innovative technologies with the parameters of justification of the choice of their optimal option

If to analyze the feasibility of choosing technologies based on the significance of the parameters, then "integration" (0.286, according to Table 1) is significantly manifested in the technologies of integrating online platforms with biometric data of the company's clients, interactive training services of the company's clients and an interactive jewelry design studio. This parameter will allow for the unhindered exchange of

information between different systems, which will increase the efficiency of the work of the "Golden Dukat" company, as well as a personalized approach to each client and automation of interaction processes with them. The parameter "interactivity" has high values for all technologies of the "Golden Dukat" company, but its significance (0.190, according to Table 1) is lower compared to others. In practice, the parameter "interactivity" can be compensated by "autonomy" and "machine learning". The parameter "adaptability" showed the lowest level of impact on the intellectualization of technologies.

The intersection of fuzzy sets $\widetilde{CONF_i}$ helps to determine the optimal intellectual and innovative technology for the company "Golden Ducat". According to the degrees of correspondence of the fuzzy solution $\widetilde{Des}$, this characterizes the degree of optimality of each of the analyzed technologies:

$$\mu_{\widetilde{Des}}Q_1 = \min(0.9714;0.7343;0.9767;0.8635;0.7871) = 0.7343;$$

$$\mu_{\widetilde{Des}}Q_2 = \min(0.9212;0.5458;0.9039;0.7564;0.4716) = 0.4716;$$

$$\mu_{\widetilde{Des}}Q_3 = \min(0.9087;0.4050;0.8962;0.6142;0.6451) = 0.4050;$$

$$\mu_{\widetilde{Des}}Q_4 = \min(0.8740;0.3184;0.8896;0.6142;0.2335) = 0.2335;$$

$$\mu_{\widetilde{Des}}Q_5 = \min(0.8845;0.3409;0.8836;0.7008;0.6456) = 0.3409.$$

So, the fuzzy set of optimal solutions:

$$\widetilde{Des} = \left\{\frac{0.7343}{Q_1};\frac{0.4716}{Q_2};\frac{0.4050}{Q_3};\frac{0.2335}{Q_4};\frac{0.3409}{Q_5}\right\}. \quad (8)$$

The analysis made it possible to determine the nature of the influence of intellectualization parameters in the enterprise's innovative technologies on their interaction with customers, in particular, taking into account the conditions of sustainable development. However, among the analyzed technologies, there is no one that would fully satisfy the conditions of the developed system, since there is no element with a degree of correspondence close to unity in the fuzzy set.

An interactive jewelry design studio satisfies the intellectualization parameters by 73.43 %, 3D visualization and virtual measurement of selected jewelry by 47.16 %, integration of online platforms with biometric data of the company's customers by 40.50 %, eco-design of the company's products by 23.35 %, interactive training services for the company's customers by 34.09 %.

**3.8. Comparison of the parameters of the company's technology intellectualization with the expected economic indicators of the enterprise**

The determined levels of technology intellectualization indicate the nature of the impact and depth of the company's interaction with customers, however, to substantiate the economic feasibility of their practical implementation, a number of additional economic indicators should be taken into account. For this purpose, investment options for the specified technology projects were considered, based on research conducted by the "Golden Ducat" company (in terms of financial indicators) and average market indicators (in terms of forecasting consumer behavior in the subject area). A number of the most important indicators are given in Table 4.

So, according to Table 4, it is obvious that among the analyzed technologies, the most appropriate from an economic standpoint should be considered an interactive jewelry design studio (the ROI of the project of this technology is 64.19 %) and the introduction of eco-design of products (ROI – 69.47 %). The payback periods in both cases are quite short – 7.3 and 7.2 months, respectively. However, the first of these technologies is characterized by a significantly higher level of intellectualization – 73.43 %, compared to the second – 23.35 %. The annual growth rate of the average check size and client base for the technology of introducing eco-design are also significantly lower than for the technology of the interactive design studio. When choosing a technology implementation project, it is necessary to additionally study long-term trends and patterns of market progress and make strategic decisions. In particular, the stability of the growth of sustainable development trends indicates that the decision to introduce eco-design will not lose its relevance in the coming years. On the other hand, the digitalization of the economy determines the need for interactive interactions with customers, and therefore the implementation of an interactive design studio also looks promising.

Other types of analyzed technologies – 3D visualization and virtual fitting of jewelry and integration of an online platform with biometric data of customers of the "Golden Dukat" company showed a significantly lower level of ROI: 38.34 % and 38.09 %, as well as a slightly longer payback period, 12.8 and 8.6 months, respectively. These innovative technologies are less consistent with the parameters of the intellectualization system (47.16 % and 40.50 %), compared to the others described above. However, they are also promising for implementation by the company in the current conditions.

**Table 4**

Indicators of economic feasibility of implementing intellectual and innovative technologies of the "Golden Ducat" Jewelry Company

| Indicators, units of measurement | Intellectual and innovative technologies | | | | |
|---|---|---|---|---|---|
| | Interactive jewelry design studio ($Q_1$) | 3D visualization and virtual fitting of selected jewelry ($Q_2$) | Integration of online platform with biometric data of company clients ($Q_3$) | Eco-design of company products ($Q_4$) | Interactive training services for company clients ($Q_5$) |
| Level of compliance of technology with the parameters of the intellectualization system, % | 73.43 | 47.16 | 40.50 | 23.35 | 34.09 |
| Investments for technology implementation, USD | 25,000 | 16,700 | 5,240 | 19,050 | 5,000 |
| Expected annual growth in the average check size, % | 15.0–17.5 | 12.5–15.0 | 4.5 | 2.0–4.0 | 2.3–3.5 |
| Expected annual growth in the customer base, % | 5.7 | 3.4 | 4.0 | 3.0 | 2.0 |
| Company income (due to the corresponding technology), USD | 231,533.35 | 23,056.54 | 7,233.30 | 32,518.60 | 7,701.75 |
| Other expenses, USD | 238.10 | 238.10 | 238.10 | 238.10 | 238.10 |
| ROI, % | 64.19 | 38.34 | 38.09 | 69.47 | 54.03 |
| Expected payback period, months | 7.3 | 12.8 | 8.6 | 7.2 | 7.8 |

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The implementation of interactive customer training services by the company is promising for implementation, compared to other technology projects. The ROI indicator is 54.03 %, and the payback period is 7.8 months, which confirms the expected effectiveness of such a solution.

The calculations presented in Table 4 have shown that hypothesis 2 is not fully confirmed. The level of intellectualization of the analyzed technologies does not always determine the increase in the profitability of the enterprise. After all, individual technologies demonstrate a high level of intellectualization and profitability, but other technologies, with a significantly lower level of intellectualization, show no less profitable economic results. This dictates the need to take into account additional factors, in particular, such as market demand, long-term trends and features of business functioning.

**3.9. Discussion of the results of the economic evaluation of intellectual and innovative technologies of an enterprise in the context of sustainable development**

To study the issues of the economic evaluation of intellectual and innovative technologies in the context of sustainable development, a bibliometric analysis was carried out based on the scientometric database *"Scopus"* and on the basis of the *VosViewer* tool, which showed a significant lack of developments in the subject area. The term "intellectual and innovative technologies" is mentioned in 1104 documents, of which only 48 relate to the topic of sustainable development. During such an analysis, several main clusters in the use of this term were identified, among which contexts related to the economy, intellectual property rights, ecology and digitalization dominate. At the same time, this demonstrated the interdisciplinary nature of the problem, and therefore, solving the issues of the economic evaluation of intellectual and innovative technologies requires a comprehensive approach that combines economic, environmental and social components. Therefore, this vision was applied during further justifications in this work.

To study the specified issues, the "Golden Dukat" Jewelry Company, which specializes in the production and sale of jewelry for the middle and premium segments, was selected. The study showed that the company faces a number of challenges, in particular, the loss of communication with customers, a decrease in profitability, and insufficient integration of innovative technologies and principles of sustainable development. The main problems are the low level of personalization of interaction with consumers, weak integration with digital platforms, the lack of interactive services and training programs, as well as insufficient attention to environmental responsibility in production processes. Therefore, the company served as a basis for considering projects for its implementation of intellectual and innovative technologies (digital platforms, personalization systems, interactive services, environmentally responsible practices, etc.). The study of this topic using the example of the "Golden Ducat" company showed that intellectual and innovative technologies open up prospects for creating new business models based on the digitalization of processes and the integration of modern approaches to customer service. Their implementation makes it possible to reduce operating costs through automation and optimization of work processes, which is especially important in conditions of increasing competition in the market. In addition, such technologies contribute to obtaining valuable analytics that help make informed strategic decisions, adapting to rapidly changing market conditions and customer needs. This provides the company with long-term stability, sustainable growth and an increase in its market positions.

However, the study made it possible to prove that the implementation of intellectual and innovative technologies is usually accompanied by financial, technical, personnel, market, environmental and social risks. The main challenges are high costs, possible technical failures, lack of qualified personnel, resistance to change, cybersecurity threats, rapidly changing consumer trends, and insufficient environmental friendliness of solutions.

To overcome the problems associated with the insufficient level of interaction of the "Golden Dukat" company with the market environment, optimization of production resources and implementation of sustainable development principles, the company was offered solutions. Namely, interactive design studio, 3D visualization, integration of biometric data, eco-design and interactive training services, which are aimed at creating a unique customer experience, increasing consumer loyalty and strengthening the company's competitive advantages. Particular attention was paid to the implementation of environmentally responsible practices that not only contribute to reducing costs, but also form a positive brand image among conscious consumers.

The study showed that the economic and strategic effect of such technologies is to increase the average check, reduce the number of returns, expand the customer base and improve interaction with the target audience. Successful implementation of these solutions can not only modernize business processes, but also ensure stable growth of the company, meeting modern market trends and customer expectations. At the same time, the above will be accompanied by a number of limitations and risks associated with financial costs, technical difficulties of integration, possible personnel resistance, cybersecurity threats, as well as uncertainty of market perception and economic efficiency. In addition, there are risks associated with the implementation of environmental practices and their compliance with customer expectations. To reduce these risks, careful planning, employee training, ensuring data protection and adapting solutions to changing market conditions are necessary, which will ensure the successful implementation of innovations and stable development of the company.

For the effective implementation of intellectual and innovative technologies in the activities of the "Golden Ducat" company, they were carefully assessed for intellectualization and its expected impact on the company's economic indicators. The key parameters proposed by the author's system, such as autonomy, adaptability, machine learning, interactivity and integration, provide various aspects of intellectualization, including personalization, automation, analytics and system integration. Unlike the known ones, their implementation allows to optimize resources, improve interaction with customers and support the principles of sustainable development. At the same time, the objectivity of evaluating justified parameters is complicated by the lack of clear metrics, dependence on data quality, high implementation cost and the risk of technical failures. It should be noted that *hypothesis 1*, about the positive impact of technology intellectualization on operations, convenience and personalization, is confirmed, but the success of the enterprise depends not only on customer loyalty. Practical study of the topic of this work allows to assert that important factors are also product quality, emotional connection with customers, market conditions and the human factor. Thus, the proposed system of parameters requires a comprehensive approach to evaluation, taking into account not only technical aspects, but also economic feasibility and real impact on business processes.

The system of parameters for economic evaluation and selection of optimal intellectual and innovative technologies is based on the Saaty paired comparison method. This approach made it possible to assess the qualitative characteristics of technologies by the degree of their significance, in particular: autonomy, adaptability, machine learning, interactivity and integration. The assessment was carried out through expert comparisons, the results of which were entered into a square inverse-symmetric matrix that takes into account transitivity between elements. The degree of compliance of each technology with the given parameters was determined using fuzzy sets, which ensures objectivity and consistency of assessments. The optimal technology is defined as one that demonstrates the highest compliance with all parameters. In cases of unequal significance of parameters, weighting coefficients are used, which allow taking into account their different impact on the effectiveness of the assessment. Unlike the known ones, the proposed approach provides a comprehensive analysis of intellectual and innovative technologies, contributing to the adoption of well-founded decisions on their implementation.

Comparison of intellectual and innovative technologies of the "Golden Dukat" company based on the author's system of parameters showed the priority of development of "adaptability", "integration" and "interactivity" to ensure the competitiveness of the company's technologies. At the same time, "autonomy" and "machine learning" remain less in demand due to limitations in the context of specific implementation conditions, such as data availability or the need for constant monitoring. For effective improvement of technologies, it is important to take into account the relevance of parameters in specific conditions and periodically review the evaluation system, adjusting it in accordance with the needs of the business and the algorithm of the author's model. This will ensure the integrity of the approach and adaptation to changing market conditions. The results of the analysis demonstrate that the most intellectualized technology is the interactive jewelry design studio, which meets the parameters by 73.43 %. Other technologies have lower degrees of compliance: 3D visualization and virtual fitting – 47.16 %, integration of online platforms – 40.50 %, interactive learning services – 34.09 %, eco-design of company products – 23.35 %. The study showed that the greatest impact on the level of intellectualization is exerted by the "autonomy" and "machine learning" parameters, which ensure the ability of technologies to adapt to changing conditions and automatically make decisions. The parameters "integration" and "interactivity" are also important for ensuring effective interaction with customers and creating integrated ecosystems. In contrast, "adaptability" demonstrated the least impact on the overall level of intellectualization. However, among the technologies considered, there is no solution that would fully satisfy all the parameters of the intellectualization system. At the same time, the results allow to identify priorities for further improvement of technologies and their adaptation to the conditions of sustainable development, which will contribute to increasing the efficiency of the company's work.

A study of the economic feasibility of implementing intellectual and innovative technologies of the "Golden Dukat" company showed that the most effective from an economic point of view are the interactive jewelry design studio (ROI – 64.19 %, payback period – 7.3 months) and eco-design of products (ROI – 69.47 %, payback period – 7.2 months). At the same time, a comparison with the intellectualization parameters indicates that the interactive design studio has a significantly higher level of intellectualization (73.43 %), which makes it more promising in the conditions of digitalization of the economy. Other technologies, such as 3D visualization and virtual fitting of selected jewelry, integration of online platforms with biometric data and interactive learning services, demonstrate lower ROI indicators (38.34 %, 38.09 % and 54.03 %, respectively) and a longer payback period. However, they also have the potential for implementation, given their ability to improve customer interaction and optimize business processes.

The study findings confirm that a high level of technological intellectualization does not always correlate with maximum economic effect, which shows incomplete confirmation of *hypothesis 2*. The effectiveness of technology implementation depends on many factors, including market demand, sustainable development trends and business specifics. This emphasizes the need for a strategic approach to technology selection, taking into account not only economic, but also long-term perspectives and current market needs.

## 4. Conclusions

A number of intellectual and innovative technologies with a high level of intellectualization were considered. Among them: interactive jewelry design studio, 3D visualization and virtual fitting of jewelry, integration of online platforms with biometric customer data, eco-design of products and interactive customer training services. The study confirmed that the implementation of the above-mentioned intellectualized technologies can increase the efficiency of business processes, improve the competitiveness of the company and create a unique customer experience that will meet modern market trends and principles of sustainable development.

The work developed a system of parameters for assessing the level of intellectualization of the proposed technologies for the "Golden Ducat" Jewelry Company, among which the key ones are: autonomy, adaptability, machine learning, interactivity and integration.

The developed theoretical and methodological basis in the subject area contributed to the development of a methodology for the economic evaluation of intellectual and innovative technologies for the "Golden Ducat" Jewelry Company. The application of the Saaty paired comparison method is proposed to determine the degrees of significance of key parameters and compare technologies. The developed evaluation system is based on the formation of a square inverse-symmetric matrix, which takes into account logical transitivity and consistency of expert assessments. The optimal technology is defined as the one that has the maximum degree of correspondence for all parameters, taking into account weight coefficients.

A comparative analysis of intellectual and innovative technologies of the "Golden Dukat" company using the author's system of parameters and the paired comparison method showed that the most significant parameters are "adaptability" (42.8 %), "integration" (28.6 %) and "interactivity" (19.0 %). Of lesser significance are "autonomy" and "machine learning" (4.8 % each). According to the results of the analysis, adaptability turned out to be a key parameter that ensures an effective response to changes in external conditions, process adaptation and increased competitiveness. Integration contributes to the creation of a single ecosystem for the integration of data, processes and functions, ensuring the smooth operation of technologies. Interactivity improves interaction with users, creating a convenient and personalized customer experience. Autonomy and machine learning, although important, are less in demand due to the limitations of their use in a specific context of the company.

The level of compliance of each analyzed intellectual and innovative technology with the parameters of intellectualization was determined. In particular, the highest compliance was shown by the interactive jewelry design studio (73.43 %), followed by 3D visualization (47.16 %) and the integration of online platforms with biometric data (40.50 %). Thus, the interactive jewelry design studio and 3D visualization and virtual jewelry fitting are the most intellectualized solutions that provide a high level of personalization and effective interaction with customers. The integration parameter (0.286) significantly affects the efficiency of technologies, ensuring seamless interaction between systems and personalization of services. Interactivity has a significant impact, but its effect can be enhanced due to autonomy and machine learning. Other technologies (eco-design – 23.35 % and training services – 34.09 %) also have prospects for implementation, but their level of intellectualization is lower. None of the technologies fully satisfies all the intellectualization parameters, which indicates the need for further improvement of models and assessment processes.

The analysis of the economic feasibility of implementing intellectual and innovative technologies in the "Golden Ducat" company showed that the most profitable solutions are an interactive jewelry design studio (ROI – 64.19 %, payback period – 7.3 months) and eco-design of the company's products (ROI – 69.47 %, payback period – 7.2 months). Despite similar payback periods, the design studio has a significantly higher level of intellectualization (73.43 %), which makes it a priority choice for implementation. 3D visualization and integration of an online platform with biometric data demonstrate a lower ROI (38.34 % and 38.09 %) and a longer payback period (12.8 and 8.6 months), but remain promising in the conditions of modern market requirements. Interactive customer training services showed an ROI of 54.03 % with a payback period of 7.8 months, which confirms their economic feasibility. The results shown indicate that a high level of intellectualization does not always guarantee higher profitability. When choosing technologies, it is important to consider factors such as market demand, long-term trends, and business specifics.

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## Conflict of interest

The authors declare that they have no conflict of interest regarding this study, including financial, personal, authorship or other, that could influence the study and its results presented in this article.

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## Data availability

Data will be provided upon reasonable request.

## Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

### References

1. Spending on digital transformation technologies and services worldwide from 2017 to 2027 (in trillion U.S. dollars) (2024). Statista. Available at: https://www.statista.com/statistics/870924/worldwide-digital-transformation-market-size/
2. PwC. Available at: https://www.pwc.com/ua/uk/about.html
3. Our Research. McKinsey Global Institute. Available at: https://www.mckinsey.com/mgi/our-research/all-research
4. Za rezultatamy doslidzhennia Deloitte 2024 Global Human Capital Trends naiaktualnishymy pytanniamy u sviti ye dovira ta stalyi rozvytok liudskoho kapitalu (2024). Deloitte. Available at: https://www2.deloitte.com/ua/uk/pages/press-room/press-release/2024/human-capital-trends.html
5. Pererva, P., Kuchynskyi, V., Kobielieva, T., Kosenko, A., Maslak, O. (2021). Economic substantiation of outsourcing the information technologies and logistic services in the intellectual and innovative activities of an enterprise. Eastern-European Journal of Enterprise Technologies, 4 (13 (112)), 6–14. https://doi.org/10.15587/1729-4061.2021.239164
6. Prokhorova, V., Mrykhina, O., Koleshchuk, O., Stepura, T., Zaitseva, A., Slastianykova, K. (2024). Assessment of digital culture in sustainable university development systems. Eastern-European Journal of Enterprise Technologies, 6 (13 (132)), 73–87. https://doi.org/10.15587/1729-4061.2024.317063
7. Mrykhina, O., Lisovska, L. (2020). Methodical Approach to Pricing of R&D Products During their Transfer from Universities to Business Environment. 2020 IEEE 15th International Conference on Computer Sciences and Information Technologies (CSIT), 241–246. https://doi.org/10.1109/csit49958.2020.9321884
8. Prokhorova, V., Yemelyanov, O., Koleshchuk, O., Us, Y. (2024). Innovative approaches to evaluating energy efficiency potential at enterprises. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 6, 178–185. https://doi.org/10.33271/nvngu/2024-6/178
9. Alami, H., Lehoux, P., Auclair, Y., de Guise, M., Gagnon, M.-P., Shaw, J. et al. (2020). Artificial Intelligence and Health Technology Assessment: Anticipating a New Level of Complexity. Journal of Medical Internet Research, 22 (7), e17707. https://doi.org/10.2196/17707
10. Li, X., Nosheen, S., Haq, N. U., Gao, X. (2021). Value creation during fourth industrial revolution: Use of intellectual capital by most innovative companies of the world. Technological Forecasting and Social Change, 163, 120479. https://doi.org/10.1016/j.techfore.2020.120479
11. Bilan, Y., Mishchuk, H., Roshchyk, I., Kmecova, I. (2020). An Analysis of Intellecutal Potential and its Impact on the Social and Economic Development of European Countries. Journal of Competitiveness, 12 (1), 22–38. https://doi.org/10.7441/joc.2020.01.02
12. Kang, Y. (2023). Research on intellectual property financing mode of technology-based small and medium-sized enterprises. Financial Engineering and Risk Management, 6 (1). https://doi.org/10.23977/ferm.2023.060106
13. Farzaneh, M., Wilden, R., Afshari, L., Mehralian, G. (2022). Dynamic capabilities and innovation ambidexterity: The roles of intellectual capital and innovation orientation. Journal of Business Research, 148, 47–59. https://doi.org/10.1016/j.jbusres.2022.04.030
14. Secundo, G., Ndou, V., Vecchio, P. D., De Pascale, G. (2020). Sustainable development, intellectual capital and technology policies: A structured literature review and future research agenda. Technological Forecasting and Social Change, 153, 119917. https://doi.org/10.1016/j.techfore.2020.119917
15. Bai, C., Dallasega, P., Orzes, G., Sarkis, J. (2020). Industry 4.0 technologies assessment: A sustainability perspective. International Journal of Production Economics, 229, 107776. https://doi.org/10.1016/j.ijpe.2020.107776
16. Gross-Gołacka, E., Kusterka-Jefmańska, M., Jefmański, B. (2020). Can Elements of Intellectual Capital Improve Business Sustainability? – The Perspective of Managers of SMEs in Poland. Sustainability, 12 (4), 1545. https://doi.org/10.3390/su12041545
17. Miranda, J., Ponce, P., Molina, A., Wright, P. (2019). Sensing, smart and sustainable technologies for Agri-Food 4.0. Computers in Industry, 108, 21–36. https://doi.org/10.1016/j.compind.2019.02.002
18. Oláh, J., Aburumman, N., Popp, J., Khan, M. A., Haddad, H., Kitukutha, N. (2020). Impact of Industry 4.0 on Environmental Sustainability. Sustainability, 12 (11), 4674. https://doi.org/10.3390/su12114674
19. What Are Customer Expectations, and How Have They Changed? Salesforce. Available at: https://www.salesforce.com/resources/articles/customer-expectations/
20. Consumer Trends Index 2023. Available at: https://www.cheetahdigital.com/wp-content/uploads/0323_MG_CTI_Infographic_Global-4.pdf
21. Shoda, A. (2024). The Power of Personalization: How Tailored Customer Experiences Fuel Business Growth. Doola. Available at: https://www.doola.com/blog/the-power-of-personalization-how-tailored-customer-experiences-fuel-business-growth/
22. Asotsiatsiia riteileriv Ukrainy (2024). Available at: https://rau.ua/dosvid/personalizatsiyu-na-sajti-retail/
23. How To Create a Customer-Centric Experience (2022). Salesforce. Available at: https://www.salesforce.com/blog/how-to-create-a-customer-centric-experience/
24. Statista. Available at: https://www.statista.com/
25. McKinsey & Company. Available at: https://www.mckinsey.com/
26. Deloitte. Available at: https://www2.deloitte.com/ua/uk.html
27. Sorokina, L. V., Hoiko, A. F. (2017). Rozdil 1.5.2. Ekspertna otsinka efektyvnosti proektnykh rishen na osnovi teoriyi nechitkykh mnozhyn. Ekonometrychnyi instrumentariy upravlinnia finansovoiu bezpekoiu pidpryiemstv budivnytstva. Kyiv: FOP Cherniavskyi D.O., 51–57.
28. Rotshtein, O. P. (1999). Intelektualni tekhnolohiy identyfikatsiyi: nechitki mnozhyny, henetychni alhorytmy, neironni merezhi. Vinnytsia: Universum-Vinnytsia, 323.
29. Prokhorova, V., Mrykhina, O., Koleshchuk, O., Demianenko, T. (2024). Assessing the effectiveness of implementing immersive technologies within university sustainable development systems. Eastern-European Journal of Enterprise Technologies, 5 (13 (131)), 35–47. https://doi.org/10.15587/1729-4061.2024.314232

***Viktoriia Prokhorova,*** *Doctor of Economic Sciences, Professor, Acting Head of Department of Economics and Management, Educational-Scientific "Ukrainian Engineering Pedagogics Academy", V. N. Karazin Kharkiv National University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0003-2552-2131*

***Oleksandra Mrykhina,*** *Doctor of Economic Sciences, Professor, Department of Business Economics and Investment, Lviv Polytechnic National University, Lviv, Ukraine, ORCID: https://orcid.org/0000-0002-0567-2995*

✉***Orest Koleshchuk,*** *Doctor of Economic Sciences, Associate Professor, Department of Business Economics and Investment, Lviv Polytechnic National University, Lviv, Ukraine, e-mail: orest.y.koleshchuk@lpnu.ua, ORCID: https://orcid.org/0000-0001-8995-5206*

***Anatoliy Babichev,*** *PhD, Associate Professor, Vice-Rector for Scientific and Pedagogical Work, V. N. Karazin Kharkiv National University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-7587-4824*

***Iuliia Dudnieva,*** *PhD, Associate Professor, Department of Economics and Management, Educational-Scientific "Ukrainian Engineering Pedagogics Academy", V. N. Karazin Kharkiv National University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-4786-7213*

***Krystyna Slastianykova,*** *Assistant, Department of Economics and Management, Educational-Scientific "Ukrainian Engineering Pedagogics Academy", V. N. Karazin Kharkiv National University, Kharkiv, Ukraine, ORCID: https://orcid.org/0000-0002-7114-5165*

✉*Corresponding author*