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Use of virtual and augmented reality technologies as a tool for enhancing the competitiveness of the interior design business

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Abstract. *The modern interior design business faces a high level of competition and constantly changing consumer demands, which necessitate the implementation of innovative technologies to enhance the efficiency of company operations. The use of virtual and augmented reality technologies has become particularly relevant, as they enable the creation of interactive projects, improve communication with clients, and optimize the decision-making process in interior design. The **purpose of this article** is to provide a comprehensive analysis of the possibilities for applying VR and AR technologies to enhance the competitiveness of the interior design business, identify their advantages and limitations, and assess their practical impact on business processes and client interactions. **Methods.** The study employs a systematic approach to evaluate the integration of VR and AR into the operations of interior design studios and a comparative analysis of practical cases demonstrating different strategies for implementing virtual and augmented solutions in the interior design process. Additionally, an analytical review of*



contemporary scientific publications and practical examples was conducted, allowing for the systematization of data regarding the impact of these technologies on client engagement and the speed of design decision-making. **Results.** The research indicates that the implementation of VR and AR technologies significantly enhances project visualization quality, reduces the time required to coordinate decisions with clients, and provides a more personalized approach tailored to each client. Moreover, the use of interactive tools contributes to increased client loyalty, expansion of the order portfolio, and creation of competitive advantages in the market. It was found that the most effective strategies are combined approaches that integrate VR tours with AR demonstrations of materials and furniture, allowing the virtual experience to closely approximate reality. **Conclusions.** The use of virtual and augmented reality technologies is an effective tool for enhancing the competitiveness of the interior design business, as it optimizes design processes, improves client interaction, and creates additional value for the customer. The further development and adaptation of VR and AR technologies as immersive tools will contribute to enhancing the innovative potential of companies and ensuring sustainable competitive advantages in the interior design market.

Keywords: digital design, business processes, client experience, innovative solutions, interior visualization.

Використання технологій віртуальної та доповненої реальності як інструменту підвищення конкурентоспроможності інтер'єрного бізнесу

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Анотація. Сучасний інтер'єрний бізнес стикається з високим рівнем конкуренції та постійними змінами споживчих запитів, що зумовлює необхідність впровадження інноваційних технологій для підвищення ефективності діяльності компаній. Особливої актуальності набуває використання технологій віртуальної та доповненої реальності, які дозволяють створювати інтерактивні проєкти, покращувати комунікацію з клієнтами та оптимізувати процес прийняття рішень у сфері дизайну інтер'єрів. **Мета** статті полягає у комплексному аналізі можливостей застосування VR і AR технологій для підвищення конкурентоспроможності інтер'єрного бізнесу, визначенні їхніх переваг і обмежень, а також оцінці практичного впливу на бізнес-процеси та взаємодію з клієнтами. **Методи.** У дослідженні використано системний підхід для оцінки інтеграції VR та AR у роботу інтер'єрних студій, а також порівняльний аналіз практичних кейсів, що демонструють різні стратегії впровадження імерсивних рішень у процес проєктування інтер'єрів. Додатково застосовано аналітичний огляд сучасних наукових публікацій та практичних прикладів, що дозволяє систематизувати дані щодо впливу технологій на рівень залученості клієнтів та швидкість прийняття дизайнерських рішень. **Результати.** Показано, що впровадження VR і AR технологій значно підвищує якість візуалізації проєктів, скорочує час узгодження рішень із замовником та забезпечує більш персоналізований підхід до клієнта. Крім того, застосування інтерактивних інструментів сприяє зростанню лояльності клієнтів, розширенню портфеля замовлень та створенню конкурентних переваг на ринку. Виявлено, що найбільш ефективними є комбіновані підходи, які інтегрують VR-тури з AR-демонстраціями матеріалів та меблів, що дозволяє максимально наблизити віртуальний досвід до реального. **Висновки.** Використання технологій віртуальної та доповненої реальності є ефективним інструментом підвищення конкурентоспроможності інтер'єрного бізнесу, оскільки дозволяє



оптимізувати процеси проєктування, покращити взаємодію з клієнтами та створити додаткову цінність для замовника. Подальший розвиток та адаптація імерсивних інструментів сприятимуть підвищенню інноваційного потенціалу компаній та дозволять забезпечити стійкі конкурентні переваги на ринку дизайну інтер'єрів.

Ключові слова: *цифровий дизайн, бізнес-процеси, клієнтський досвід, інноваційні рішення, візуалізація інтер'єрів.*

Problem statement. Modern interior businesses operate in conditions of high competition and rapid changes in consumer preferences, creating challenging conditions for the development and market competitiveness of companies. Traditional methods of working with clients, in particular design and presentation of interior solutions, are not effective enough to ensure rapid adaptation to individual consumer requests and increase customer engagement. The growing role of digital technologies in business processes, particularly innovative visualization solutions, necessitates the search for new tools that enable the integration of modern technologies into the work of interior studios, optimize project creation processes, and increase the efficiency of client communication.

The problem is that, despite the active development of virtual (VR) and augmented (AR) reality technologies, their comprehensive application in the field of interior business remains insufficiently studied and systematized. Most practical cases are limited to individual elements of technologies without integration into the overall design process and interaction with clients. The lack of a structured approach to the use of VR and AR in the work of interior studios limits their competitive potential. It slows down the process of creating personalized design solutions in accordance with customer requests.

Thus, research into the possibilities of comprehensive implementation of VR and AR technologies in the interior business becomes relevant, which includes an



analysis of modern scientific and practical developments, an assessment of the effectiveness of immersive technologies in real cases and the development of recommendations for the integration of VR / AR tools into the design, presentation and customer service processes.

Analysis of recent research and publications. Analysis of modern scientific publications indicates an increased interest among researchers in the use of VR and AR technologies in the fields of interior design and business practices, which directly correlates with the issue of enhancing the competitiveness of enterprises.

D. Verzhyskovskyi investigates the use of VR/AR in digital marketing of the luxury segment, emphasizing their impact on customer engagement and loyalty through virtual showrooms and interactive fitting rooms [1]. M. Ungurian and co-authors show that digital innovations increase the effectiveness of strategic marketing planning through personalization and predictive analytics [2]. In Ukrainian scientific discourse, considerable attention is paid to the conceptualization of the concepts of VR, AR and the definition of the specifics of the corresponding computer systems (V. Volynets [3]), as well as the testing of the visual qualities of the architectural environment using these technologies (V. Lytovko et al. [4]). V. Boyko's study [5] proves the effectiveness of AR as a tool for optimizing design processes in interior design, while I. Antonenko [6] emphasizes the possibilities of VR in creating digital interiors and new forms of interaction with clients.

V. Klivak [7] and E. Chaban and N. Kryvoruchko [8] emphasize the features of UX/UI design and methods of integrating digital solutions into spatial planning. At the same time, M. Vorobchuk et al. [9] and T. Mironova [10] consider immersive technologies as innovative design tools and means of expanding the creative possibilities of artists. The issue of using digital technologies in the design of the internal environment of civil buildings is highlighted by S. Kysil, O. Poliakova and T. Bulgakova [11], and Y. Trach [12] demonstrates the prospects of VR reconstruction of cultural heritage sites, which also finds practical application in the



formation of unique design solutions. In the international scientific literature, special attention is paid to the applied aspects of AR/VR in design. In particular, Y.-S. Chang et al. [13] investigated the effectiveness of mobile AR solutions in educating interior design students, while H. Trivedi and N. A. Dubey [14] conducted a general review of AR application practices in this area. The work of K. Stanney et al. focused on the problem of cyber-morbidity that arises when using immersive technologies and suggested ways to overcome it, which is essential for the safe and effective implementation of VR and AR in business practice [15]. Thus, previous studies confirm the significant potential of AR/VR as tools for optimizing design processes, training, and interaction with clients. At the same time, most of the works focus on either technical or educational aspects. The question of how the implementation of AR/VR affects the competitiveness of the interior business remains insufficiently studied, ranging from the creation of a unique customer experience and reduction of design costs to the development of new business models and strategies. This study aims to fill this scientific gap.

Highlighting previously unresolved parts of the general problem. An analysis of modern scientific and practical sources reveals that most research in the field of interior business primarily focuses on traditional design methods, standard approaches to client communication, and basic visualization tools. At the same time, the comprehensive use of VR and AR technologies in the processes of creating and presenting interior solutions remains insufficiently studied. The issue of integrating VR and AR into the full cycle of interior studios' work remains insufficiently explored, from the initial stages of conceptual design to the final presentation and communication with the client. Aspects such as assessing the impact of VR and AR on customer engagement, decision-making speed, and enhancing company competitiveness have not yet been systematized. The identified gap highlights the need for research that not only summarizes existing approaches but also provides



practical orientation recommendations for the comprehensive implementation of VR and AR technologies in the interior business.

Formulation of the article's objectives (task statement). The purpose of this study is to conduct a comprehensive analysis of the potential applications of VR and AR technologies in enhancing the competitiveness of the interior business and to develop practical recommendations for their integration into company business processes.

To achieve the goal, the following tasks have been defined:

- analyze the evolution and current state of the use of VR and AR in the field of interior design;
- identify the key advantages of integrating VR and AR into the business processes of interior studios;
- investigate the impact of using VR/AR on increasing design efficiency, reducing implementation times and the level of competitiveness of companies;
- systematize practical cases of implementing VR/AR in the activities of design companies and identify opportunities for their scaling;
- outline the prospects for the development of immersive technologies in the context of the digital transformation of the interior business.

By completing these tasks, the study will help fill the scientific and practical gap in the field of innovative technologies for the interior business, emphasize the importance of digital solutions and outline ways to increase the efficiency of companies in today's competitive market.

Presentation of the primary material of the study. Interior design today is a highly popular direction that is rapidly developing, widely implementing innovative technologies in line with modern trends. Over the past decades, design has actively integrated various software and has become fully adapted to the digital environment. To maintain a client base and effectively utilize the latest tools,



designers are increasingly leveraging VR and AR technologies, tailoring them to the specific needs of the interior design business.

In the practice of interior design, two dimensions constantly coexist: «reality» and «virtuality». They are not opposed, but complement each other, forming a new quality of the creative process. Virtuality is both a concept and a practical tool that enables you to model interior spaces and gain a deeper understanding of their essence. It acts as a dynamic force that creates digital images of the interior, providing designers with new opportunities for creative interpretation and individualization of space [6, p. 429].

The concept of VR was first introduced by the American computer artist M. Kruger in the late 1960s. Today, VR is interpreted as a computer simulation of reality or the reproduction of a particular situation. VR technical means form a digital world that is transmitted to the user through their senses - vision, hearing, touch, and sometimes smell [4, p. 70].

VR is an intuitive technology that is continually developing and improving to make human interaction with digital products as natural as possible. It contributes to the creation of humanized user interfaces, where actions in the virtual environment are consistent with real human behavior [7, p. 30]. For the interior business, this means the possibility of creating interactive presentations during which the client can change the colors of the walls, the texture of materials, or the arrangement of furniture in real-time.

AR is also actively used in parallel with VR. The term “augmented reality” was introduced in 1990 by T. Codel, an employee of the Boeing aerospace corporation. Unlike VR, which completely simulates the surrounding space, AR combines real objects with those created by a computer, providing the effect of integrating the virtual and physical worlds [7, p. 30].

The concept of augmented reality opens up new horizons for the interior business, as it allows designers to work with space and time in a fundamentally new



dimension. If VR was previously mainly used in the entertainment and gaming fields, it is now becoming a powerful tool for creating individualized and competitive interior solutions. In the process of VR visualizations, the experience of working with materials and forms is transformed into the creation of atmospheric spaces. The atmosphere of the interior is formed in the client's interaction with virtual objects, and its immersive nature provides an emotional connection with the future space. VR allows you not only to «see the design», but to feel it through sensory interactions – movement, vision, hearing and sometimes even tactile sensations. It opens up new opportunities for demonstrating interior solutions to the customer: the client can «walk» through the future room, evaluate spatial solutions, lighting or color combinations. VR transforms the design process from an abstract project to a personal experience for the client, which significantly increases the competitiveness of the studio or architect.

According to the analysis of the economic effects and benefits of implementing innovative solutions in business, the impact of VR is manifested only when the digital space interacts with the human senses. In the context of the interior business, this means that digital materials – colors, textures, light – become practical tools for shaping the client experience, creating a kind of «agency gap» between the virtual and the real, due to which the future interior is perceived by the client not only visually, but also emotionally [16].

It is worth noting that a significant part of modern VR solutions in the field of design remains skeuomorphic, as they strive to reproduce reality as realistically as possible to facilitate the understanding of the new environment. However, with the growth of user experience in VR, new opportunities emerge that are not limited to simply imitating reality. Designers can apply innovative spatial modeling strategies that allow them to experiment with shapes, light, and textures, going beyond the boundaries of conventional interior solutions. It creates additional value for the client and gives the product a sense of uniqueness.



Along with VR, AR is actively developing, which requires complete immersion in a digital environment. AR works at the interface of the physical and virtual, complementing the real space with digital elements. It allows users to visualize the future interior in the format of a 3D model without creating a completely virtual environment. The client can then immediately assess the suitability of furniture, color solutions, or lighting for a specific room using a smartphone, tablet, or AR glasses.

Thus, VR and AR in the modern interior business are becoming not only presentation tools, but also mechanisms for creating an emotional and sensory experience, which increases the competitiveness of companies, ensures product individualization, and allows clients to experience the future space before its implementation.

The development of AR technologies in the field of interior design has progressed through several key stages, from initial experimental developments to the emergence of commercially available products. The history of the formation of AR shows that innovations in this area were closely related to the needs of architects and designers for more realistic visualization of space and effective communication with customers. Table 1 presents the key scientific and practical achievements that have contributed to the development of modern approaches to the application of AR in interior design.

Table 1**Evolution of the use of AR technologies in interior design**

Year	Author/Company	Essence of development
1995	K. Ahlers, European Computer-Industry Research Centre	Collective design system with integration of 3D objects into the video stream
1997	R. Azuma («A survey of augmented reality»); D. Koller et al.	Formulation of basic AR criteria; development of optical camera tracking
2003	Y. Yasumuro et al.	Interactive location of objects in space using 3D markers
2003	J. Cook (ARIS project)	Photorealistic embedding of virtual objects in photo interiors



Year	Author/Company	Essence of development
2005	Metaio GmbH (KPS Click&Design)	Embedding furniture in static photo interiors with markers
2006	S. Siltanen, C. Woodward	Advanced interface: light, shadows, erasing markers
2011	R. Nobrega, N. Correia	Embedding objects without markers thanks to image processing algorithms
2011	T. Tanaka et al.	AR-based interior design simulator (web application)
2013	IKEA (IKEA Catalog App)	The first mass AR application for previewing furniture in real space via a smartphone
2016	Microsoft (HoloLens)	Launch of mixed reality for architects and designers, integrating AR into professional projects
2017	Apple (ARKit), Google (ARCore)	The emergence of AR application development platforms has made AR available for mobile applications in the field of design
2019	Houzz AR	Popularization of AR services for selecting furniture and decor directly in the customer's premises
2020	COVID-19 and the boom of AR/VR in design	Mass use of AR and VR in remote interior presentations and online consultations
2021	IKEA Studio (Apple LiDAR)	Use of LiDAR scanning for accurate measurement of rooms and visualization of interiors in absolute scale.
2022	Adobe Aero	Integration of AR into creative environments for designers (3D modeling + AR in one environment)
2023	Foyr Neo, Morpholio AR SketchWalk	Tools for creating interactive interior concepts with the ability to walk around the room in mixed reality
2024	IKEA Kreativ, AI + AR	Using artificial intelligence together with AR to automatically replace furniture and objects in space
2025	Integrating AR with VR into unified XR systems	Using Extended Reality (XR) for full immersion, the customer can switch between AR and VR, evaluating the interior simultaneously in both the real and virtual environments

Source: author's development

Table 1 illustrates the sequential development of AR technologies in interior design, from the initial laboratory experiments with 3D markers and camera tracking in the 1990s to the modern, complex XR solutions of 2025. While initially used only for individual visualizations and testing of objects, AR gained widespread use in the 2010s thanks to mobile platforms. Further development is associated with the introduction of LiDAR scanning, the integration of 3D modeling tools and the use of artificial intelligence to automate design solutions. At the current stage, AR has



evolved into a component of XR environments that enable simultaneous work with VR and AR, providing the most realistic immersion and enhancing the competitiveness of the interior business. The use of AR is essential at the stage of presenting a design product in the interior business, as it allows the client to visualize the future space and evaluate its aesthetic and functional characteristics. If traditional visualizations reproduce only geometric parameters and artistic characteristics of the interior, then AR adds a full-fledged spatial experience. The client can see the dimensions of the elements, their volume, and their mutual arrangement on a real scale. It reduces the risk of errors, increases trust in the designer, and makes cooperation more transparent [5, p. 22].

Thus, VR and AR are not just technical innovations, but strategic tools that help interior studios create a unique client experience, enhance the quality of projects, and strengthen their competitive position in the market.

In the process of creating an interior, working with virtuality opens up opportunities for the designer to rethink space and experiment with forms. It is a kind of «laboratory space» where you can test combinations of materials, textures, colors and compositions before they are implemented in the physical environment. The use of VR and AR in this area not only facilitates object modeling but also enables the prediction of the customer's reaction to the proposed solution, which significantly increases work efficiency and provides advantages to design companies.

Figure 1 illustrates the key functions of VR and AR technologies as a tool for increasing the competitiveness of the interior business. It demonstrates how VR and AR help designers create interactive and realistic spaces, optimize decision-making processes, effectively interact with clients and the project team, and test various design solutions at the conceptual design stage. This approach helps improve the quality of services, reduce development time, and increase the product's market attractiveness.

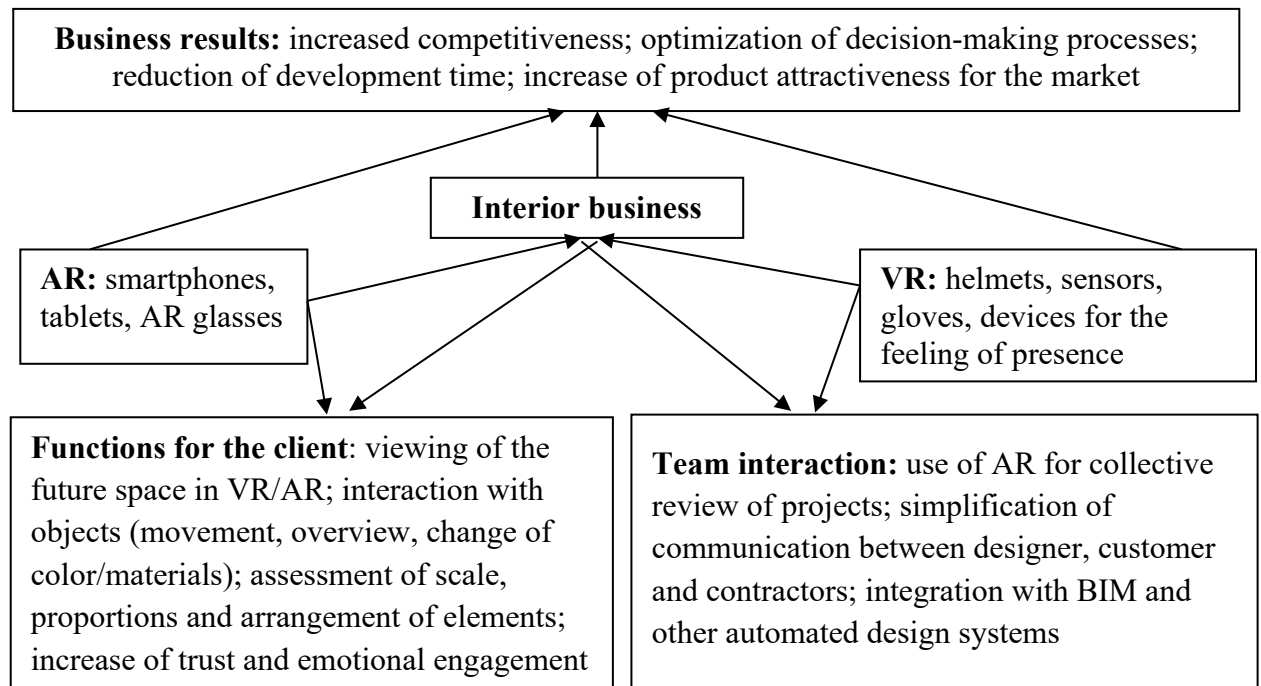


Fig. 1. Functions of VR and AR technologies as a tool for increasing the competitiveness of the interior business

Source: author's own development

The model of VR and AR functions in the interior business, presented in the figure, demonstrates that these technologies act not only as visualization tools but also as a comprehensive means of organizing the work of a design studio. In combination, they optimize the decision-making process, enhance the quality of communication between the designer, customer, and contractors, and also create a unique customer experience.

Modern VR/AR systems enable the creation of interactive models that combine time and space in a new configuration. Thanks to this, the user experiences the effect of immersion: a space that does not yet physically exist appears before the eyes in a visually and psychologically authentic form. It allows customers to evaluate the interior at the design stage, and designers to quickly make changes [4, p. 72]. Table 2 presents examples of VR/AR implementation in the practical activities of design companies with an analysis of their scaling potential.

Table 2



Practical cases of VR/AR implementation in the activities of design companies and their scaling potential

Company/tool	Implementation example	Results for customers and business	Scaling capabilities
Google Glass (VR/AR)	Displaying digital information directly in the user's field of view	Simplifying the process of interacting with data, making decisions more quickly	Scaling in the field of design and construction
Oculus Quest / Oculus Rift + Unreal Engine 5	Virtual walk through an apartment or house before implementing the design	Immersion effect, increasing customer trust, and reducing the risk of design errors	Can be used for real estate sales, architectural studios and interior design salons
IKEA Place (AR application)	Placement of virtual furniture in real space, scaling accuracy - up to 98%	Personalization of space, simplifying product selection, and increasing sales	Expanding functionality for different segments of the furniture market, and integration into marketplaces
Nike, Adidas (AR fitting)	The ability to virtually try on shoes and clothing using augmented reality	Reducing the number of product returns and increasing customer satisfaction	Using technology for furniture and decor (AR-trying on interior items)
Villeroy & Boch (AR application)	AR application for selecting furniture and plumbing in the bathroom (iOS, Android, Windows)	Realistic visualization, ease of choice, and attracting new customers	Scaling in the field of kitchen and residential interiors
BoConcept, Wayfair, etc.	Using AR/VR to present interiors on websites	Growing online sales, increasing competitiveness	Transferring technology to mobile platforms, integration with VR store tours

Source: author's development

The practical implementation of VR/AR technologies in the activities of design companies enables the achievement of different results for both clients and businesses. For example, the use of Google Glass provides prompt decision-making by displaying digital information directly in the user's field of view, which can potentially be scaled in the field of design and construction for interactive prompts. Similarly, VR platforms such as Oculus Quest, combined with Unreal Engine 5, create an immersive effect during a virtual walkthrough of a room, increasing



customer trust and reducing the risk of design errors [3]. Other examples, such as IKEA Place or AR fitting from Nike and Adidas, demonstrate that AR technologies enable personalizing spaces, simplify product selection, and increase customer satisfaction, while opening up new opportunities for scaling businesses. At the same time, AR applications from companies such as Villeroy & Boch, BoConcept, and Wayfair demonstrate that the interactive presentation of interior products on mobile and web platforms contributes to increasing online sales and creating competitive advantages.

Thus, modern immersive technologies (VR, AR, MR) have become an essential tool for the digital transformation of the interior business. They not only increase the efficiency of design and communication with customers, but also open up new channels for presenting services, forming a combination of innovation, convenience, and the emotional effect of immersion in the future space.

However, the use of AR has another aspect – the ability for users without professional training to independently model the interior using mobile applications, which creates a particular competition for professional designers. At the same time, it is worth emphasizing that such tools cannot completely replace professional design. Instead, they complement it, performing the function of visualization, preliminary familiarization with the concept and testing various solutions on a real scale. It is the combination of professional expertise and digital technologies that allows you to achieve maximum value for the client, ensures a more accurate implementation of the design idea, and forms a stable competitive advantage for the business.

Thus, VR/AR technologies not only optimize the process of creating interior solutions but also become a strategic tool for strengthening companies' positions in a competitive market environment.

Conclusions. The study confirmed that the implementation of VR and AR technologies is a strategic direction for the development of the interior business and



a necessary condition for increasing its competitiveness. Analysis of the evolution of AR/VR technologies has revealed a transition from experimental systems to complex XR solutions that enable customers to evaluate the nuances of the designed environment fully.

Comparative analysis has proven that VR provides the effect of immersion in the digital space, while AR integrates virtual elements into the real environment. It is their combination that allows not only to reduce the risks of design errors and reduce the time for coordinating solutions, but also to improve the quality of communication between the designer and the customer.

The proposed approaches to using VR/AR in the interior business contribute to product individualization, the formation of a unique customer experience, and the expansion of market opportunities. Further scientific research should focus on developing economically feasible models for integrating VR/AR into small and medium-sized businesses, as well as on examining the impact of XR systems on the professional competencies of designers and architects.

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