# Virtual Museum and the Phenomenon of Digital Heritage: Challenges of the 21st Century

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**Abstract**

The paper presents an analysis of the use of digital technology in the museum industry, the introduction of the term "museum computing" by museum specialists and the emergence of a new phenomenon – the phenomenon of a virtual museum, as a museum that uses up-to-date information and communication technology for the presentation of museum collections. It has been stated that a virtual museum can be interpreted as "an integrated cognitive system, i.e. an accessible interactive collection of complex three-dimensional artefacts or replicas of monuments created by computer methods", as well as a digital unit that shows the features of the museum to complement, improve or expand museum experience through personalization, interactivity and richness of content.

It has been emphasized that information technology has made it possible to expand the cognitive and communication potential of cultural heritage and, according to Western researchers, the third cultural (digital) revolution associated with the cyber era allows science, technology and art to be organically intertwined. Therefore, one can speak of cyber heritage, which combines art, culture and intercultural dialogue. It has been stated that the analysis of conceptual and methodical approaches to the development of state-of-the-art digital technologies in the field of cultural heritage, which caused a digital boom in all modern cultural processes, made it possible to trace the leading patterns and trends related to the recording, analysis and transmission of cultural heritage at the present stage.

Own research on the popularity of virtual museums and awareness of this issue among different segments of the population have been conducted. Statistical data based on survey results have been traced and analysed. The analysis of the results proved the relevance of the issue under study and the fact that there is no single correct context or environment, in which culture can exist. First of all, it should be where there is an audience interested in it, and since a large part of this audience is online, this gives reason to assert that virtual exhibitions are in demand and are becoming increasingly popular.

**Keywords**

Digital technology, museum industry, information technology, virtual exhibitions, virtual expositions, statistics, analysis, attendance, popularity.

## 1. Introduction

Information revolutions have been the cornerstones in the development of human civilization throughout its history. The first one took place about 4 thousand years BC with the advent of writing, which made it possible to record information and pass it on from generation to generation. The invention and spread of book printing in the 15th century and the invention of electricity in the 19th century enabled the accumulation of information in large volumes. From the middle of the twentieth century, humanity was gradually entering the computer era, which formed a new type of society – an information society, the main feature of which is the use of information technology.

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Information technology has radically changed the field of cultural heritage, which has become more globalized. The use of digital technology has fundamentally influenced the activities of museums towards their attractiveness, creativity and accessibility. The social role of museums and heritage in modern society has strengthened. A "virtual museum" is emerging as a new cultural phenomenon. All of this ultimately led to the formation of digital heritage alongside tangible and intangible cultural heritage, which is gradually becoming a separate cultural phenomenon.

## 2. Analysis of sources

A lot of studies have been devoted to the problems of digital cultural heritage. Thus, in their paper, Lviv researchers Vasyl Banakh, Zhanna Myna and Andriy Nahirnyak revealed the key stages of the development and spread of digital technology in museology from the second half of the 20th century [1]. In their other study, the researchers focused on the use of modern multimedia technology by museums (on the example of the museum of the Lviv Polytechnic National University) in the context of overcoming social distance during the COVID-19 pandemic. The authors of the paper came to the conclusion that online exhibitions, virtual reality, social networks, 3D technology allowed museum institutions not only to preserve, but also to partially expand the potential audience and make the "museum product" more accessible [2].

Maria Dalbello, a professor of library science and computer science from Toronto, has devoted a number of studies to digital cultural heritage. According to the scientist, the active development of digital technologies in the cultural sphere (in particular, museums) has led to the formation of digital cultural heritage as a "publicly accessible common identity" by attracting an online audience through social network platforms [3].

In his paper, Taras Horbul tries to reveal the concept of "digital culture", one of the phenomena of which is "digital cultural heritage" [4]. An important stage in studying the phenomenon of digital culture was a collective monograph dedicated to the priority areas of preservation, access and use of digital heritage [5].

Polish researchers Beata Skalska-Cimer and Andrzej Kadłuczka analysed the essence of the virtual museum phenomenon. According to researchers, digital artefacts of virtual museums are equal to traditional museum objects and "can become collectable, scientific and educational materials that require appropriate preservation" [6]. The well-known Ukrainian culture expert Mykhailo Kulyniak focused his attention on the concept of "digital cultural heritage". The scientist revealed the features of the implementation and use of digital technologies in order to preserve and promote cultural heritage. He generalised and analysed the foreign and Ukrainian experience in studying, preserving and spreading cultural heritage using digital technology. According to him, preservation of cultural heritage is impossible without effective use of state-of-the-art information technology [7]. Kyiv scientist Viktoriia Volynets analysed the potential of the virtual museum. In her opinion, virtual museums should not be considered only as a "mirror" of traditional museums – this would be too simple a solution and could limit their role in society. Both should be considered as complementary institutions that together provide a holistic view of culture, history, art, education, and science [8].

Attendance at museums in a digital format and the transformation of the visitor experience were investigated by Hanna Mamonova [9].

Yevheniia Tsatsenko in her paper analyses the virtual space as an additional environment for the demonstration of art and cultural heritage and innovations in the field of culture [10].

Researcher Ruslana Mankovska studies modern museum communications and the prospects for their development [11].

Thus, the analysis of scientific literature allows revealing the topic specified in the research to the full.

## 3. Virtual museums and the phenomenon of digital heritage

For the first time, issues related to cultural heritage and the active introduction of new computer technology into the museum environment began to be actively discussed in the 1970s. At that time, the use of digital technology in the museum industry consisted in the creation and use of information

retrieval systems (data banks), as well as computer networks that connected a certain number of museums.

Museum specialists proposed the term “museum computing”. Its formation began in the mid-1950s and was associated with the creation of mechanical systems for retrieving information about archaeological sites that were mapped by hand. After a symposium organized in 1968 under the auspices of the New York Metropolitan Museum of Art, “museum computing” focused on the automatic retrieval of information about museum collections. Thus, at the first stage, which falls on the 1970s and 1980s, computer technology in the context of preserving and updating cultural heritage were used by museums exclusively as an auxiliary resource. The main task is to help and organize informative databases of museum collections by creating appropriate computerized museum inventory card files. At the same time, the first attempts to use new information technologies in the exhibition work of the museum appeared.

The next stage of the use of computer technology in cultural heritage, which was crucial for its preservation and updating, was the emergence and spread of the Internet. Year 1997 can be considered its starting point, when the Archives and Museum of Informatics organised the first International Conference dedicated to museums and the World Wide Web in Los Angeles. More than 400 specialists from 25 countries took part in it. Subsequently, similar conferences were held in 1998 and 1999. A new phenomenon was emerging – the phenomenon of a virtual museum [1].

A virtual museum is a museum that uses modern information and communication technology for presentation of museum collections. The virtual museum can also be interpreted as “an integrated cognitive system, i.e. a generally available interactive collection of comprehensive 3D representations or copies of monuments created using computer methods.” The virtual museum is a digital entity that draws on the characteristics of a museum, in order to complement, enhance, or augment the museum experience through personalization, interactivity and richness of content. Two types of virtual museums can be distinguished – virtual museums available only online, virtual museums that operate on the Internet but extend the offer of traditional museums. In museums that are only virtual, we can select exhibits from different places and different museums, and build exhibitions that most likely have never been created in a traditional real museum form. A virtual museum can consist of exhibitions created from scratch or designed around one predefined theme or object [6].

The idea of digitizing museum collections in a wide format came to Google back in 2011 thanks to the famous “20% time” principle. Every Google employee has the right to spend 20% of their working time thinking about new projects. Amit Sood, being a software engineer, shared his idea with Nicholas Serota, the then head of the Tate, and Glenn Lowry, the director of the Museum of Modern Art, MoMA, and they approved his idea. After some time, the company created a special Google Art Camera, thanks to which you can view brush strokes or any other details on the canvas in a wide format, and then started developing the website. Currently, the Institute cooperates with 1.5 thousand museums and cultural institutions in 70 countries. Google Arts & Culture is now much more than just a digital repository of collections of works of art – the project itself has become a producer of cultural content with a huge audience reach [12].

The transformation of the virtual museum into a “new cultural reality” has put issues on the agenda related to the “essence” of the museum, its connection with knowledge and material culture. Information technology have made it possible to expand the cognitive and communication potential of cultural heritage. According to Western researchers, the third cultural (digital) revolution associated with the cyber era allows science, technology and art to be organically intertwined. Therefore, we can speak about cyber heritage, which combines art, culture and intercultural dialogue [13].

The phenomenon of the “Virtual Museum” is closely related to the broader concept of digital cultural heritage. Preservation of cultural heritage is impossible without effective use of modern information technology. Therefore, the analysis of conceptual and methodical approaches to the development of state-of-the-art digital technology in the field of cultural heritage, which caused a digital boom in all modern cultural processes, made it possible to trace the leading patterns and trends related to the recording, analysis and transmission of cultural heritage at the present stage. With the growth in the number and quality of digital images, the increase in storage space and network technologies that allow distributing high-resolution images, we can talk about the transformative impact of digital technology in the field of recording, analysis and transmission of cultural heritage [7].

The concept of “digital heritage” received statutory meaning at the international level after the UNESCO General Conference adopted the Charter on the Preservation of Digital Heritage on 15 October 2003. In accordance with Article 1, digital heritage embraces unique information resources of knowledge and forms of their functioning in the basic spheres of society’s vital activities – cultural, educational, scientific and administrative resources, as well as technical, legal, medical and other kinds of information created digitally, or converted into digital form from existing analogue resources. These include paper documents, databases, still and moving images, audio, graphics, software and web pages. In the case of “digital origin”, the resources do not exist as a digital original. Among the information resources, there are many that have lasting value and significance, and need to be preserved for future generations, and therefore attention is focused on the representation in the digital heritage of all peoples, states, cultures and languages. According to Article 2 of the Charter, preservation of digital heritage is primarily aimed at ensuring its maximum improvement, which should be free from unreasonable restrictions. Article 5 of the Charter recognizes continuity of the digital heritage as the basic principle of digital heritage functioning, which requires consistent compliance throughout the entire “life cycle” (from creation to access) and includes comprehensive measures to ensure its preservation [14].

Amit Sood, Director of the Google Institute of Culture & Art Project, believes that the more digital technology that penetrate culture appear, the better it will contribute to museum attendance. In his opinion, if a person will be able to have a good look at a certain work of art on his/her monitor, which is, for example, in a famous museum in New York or London, then it is likely that, having arrived in these cities, a person will want to see this work live.

Contrary to this approach, Pedro Gadanho, Director of the Portuguese Museum of Arts, Architecture and Technology in Lisbon - MAAT (Museu Arte Arquitetura Tecnologia) – is quite critical of new trends and projects. He visited Google’s Cultural Lab in Paris when it started work on a virtual reproduction of the museum for everyone who cannot physically visit it, and he is sure that it is simply impossible to reproduce the feeling of actually being in a museum using a virtual interface.

As for virtual platforms, according to the art expert, they can enrich and expand the museum, but cannot replace it. “The fact that these issues are at the centre of the debate today, and many institutions are investing energy and resources in solving them, shows that it is on trend. But in the future, I think, we will focus more on the way artists work and convey information to users,” says MAAT’s Director. (Development of digital culture and digitalization of museums: experience of introduction and use of digital technologiy by museums of the world. (overview reference based on press materials, the Internet and unpublished documents for 2017-2019) [15].

If we take the Ukrainian context, there is some lagging behind the West – both in technology and in communication with the external environment. For the widespread adoption of technology, Ukrainian museums need effective, cost-effective and simple methods of creating virtual and augmented reality exhibitions based on their collections of 3D models. The work of creating exhibitions can be performed by museum employees who cannot be expected to be specialists in the field of information technology. However, more and more projects on digitizing museum collections are being implemented in Ukraine. In particular, a powerful start of the Ukrainian Cultural Foundation, as well as support programmes, stimulated the emergence of numerous initiatives in the country to digitize museum pieces. However, the vast majority are focused on working with the form, image, and almost no one works properly with the content. The results are mostly presented by a classic website with access to information exclusively through viewing on a monitor. By the way, in 2019, the NGO “Ukrainian Centre for the Development of Museum Affairs” (UCDMA) together with the National Museum of the History of Ukraine in the Second World War and the Estonian War Museum, with the financial support of the European Union (within the Culture Bridges programme), implemented the Museum Digital Lab project within the framework of the ProMuseum programme. The mission of the project was the development of a data infrastructure in the field of cultural heritage in Ukraine, the integration of the data of Ukrainian museums with foreign (international) data banks and networks/resources, as well as the development of digital competences among Ukrainian museum specialists [8].

## 4. Museum attendance in digital format and analysis of statistics based on survey data

The issue of museum attendance became especially pressing during the pandemic, because then virtual reality became the area on which the attention of cultural institutions was concentrated. Thus, in 2021, UNESCO reviewed the state of the museum sector and prepared a report stating that the important place that the museum sector has occupied in national cultural life over the past decades is under threat, so governments of states should urgently take appropriate measures to support them.

In the same year, 2021, four Ukrainian museums were surveyed about how much their digital attendance had grown. At the National Museum in Lviv, the reached audience in the digital space exceeded the mark of 1.5 million users for the first time. This figure is almost three times higher than the one in 2019 [9].

At the Dnipropetrovsk Art Museum, attendance in the digital space has gown nine times. The total number of visitors in 2020 was 81 thousand 300 people, of which 72 thousand 730 were online (8 thousand online visits in 2019). The number of people who came directly to the museum decreased by 40% (2019 – 14.2 thousand / 2020 – 8.5 thousand) [9]. The Khmelnytskyi Regional Art Museum, which in 2020 was visited by 14,404 people and 179,808 online, also speaks of an increase in online attendance. Each next lockdown had a negative impact on in-person attendance of the museum. It is clear that planned exhibitions and events were cancelled or postponed. According to the observations of museum workers, after the museum has resumed work after the quarantine, it took time (sometimes up to two or three weeks) to make visitors come back.

At the Khanenko Museum in Kyiv, a large increase in visitors was observed on the first weekend after opening of the institution after the lockdown. Then there is an increase on the weekend before closing for quarantine [9].

Thus, the global issues of the transformation of the attendance experience, the importance of the physical presence of a person and a work of art in a "live" exposition, the meaning and role of the museum as such have been raised. The issue of what is the mission of the museum today and how to overcome the challenges of the time is being actively discussed, because during the quarantine, museums for the most part have turned from dynamic public and inclusive places into collection repositories [9].

According to the survey results conducted by the Museum Innovation Barometer among about 200 museums from different countries around the globe, the latest technology has become an extremely important tool for cultural institutions during the pandemic. In 2020, the average assessment of the relevance of technology in museum work on a scale from 0 to 10 was 7.6 points. When asked whether the latest technology can be considered an important factor in the museum's success, 80% of respondents answered in the affirmative (Fig. 1) [10].

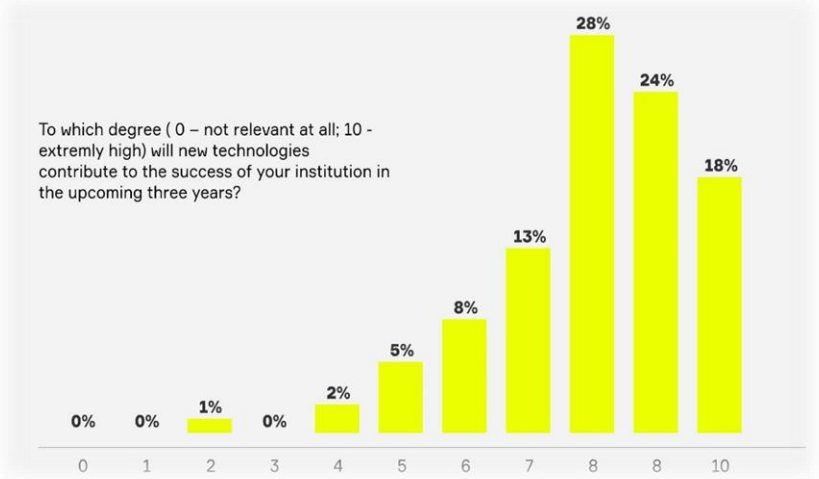


**Figure** 1: Results of the Museum Innovation Barometer survey

The authors of the paper conducted their own research on the popularity of virtual museums. A Google form was created with a list of questions formed in such a way as to find out the attitude towards the creation of 3D museums, the attitude towards the possibility of attending the museum via phone or PC, the activity of visiting virtual museums and, in general, how much interest there is in virtual museums.

As for the gender ratio, more women took part in the survey.

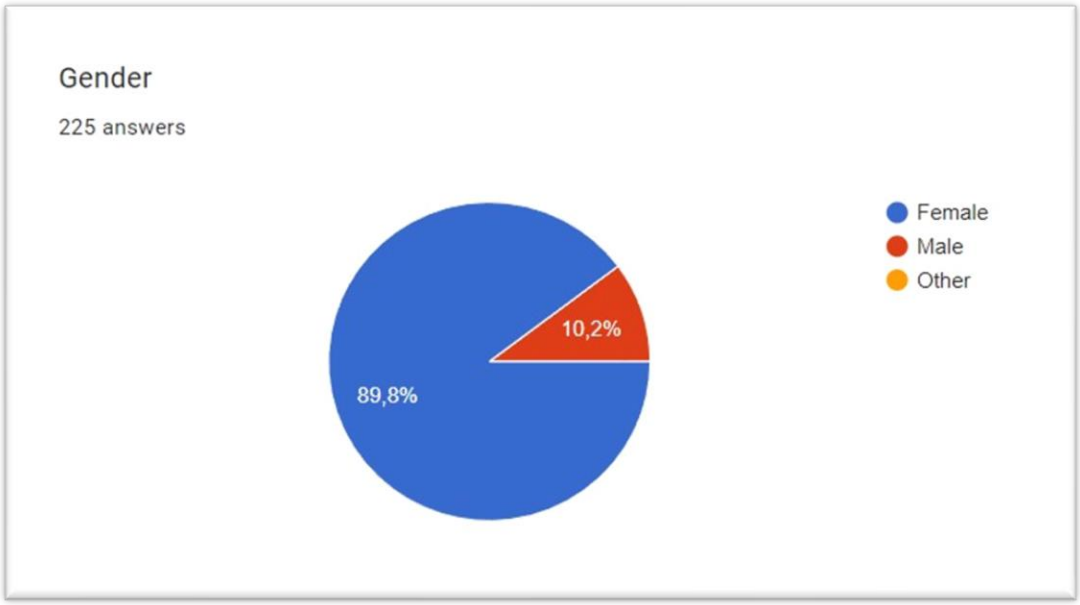


**Figure 2:** Gender ratio among respondents

Therefore, the results of the survey revealed a gender imbalance. A deeper analysis of the museum audience according to various parameters lies in the perspective of further research. Consideration should be given to the motives and needs of museum attendance. That is, an active dialogue with the audience is required, a search for ways of interaction between the museum and visitors.

Interestingly, back in 2012, the study of demographic, psychographic, personal and other aspects of visiting museums in Ukraine was carried out by the Kyiv International Institute of Sociology. Survey results also revealed a gender imbalance among visitors: three-quarters of adult museum fans were women (77%), and just under a quarter were men (23%) [11]. In our study, as we can see, the ratio is also in favour of women with a large percentage difference: 89.8% are women and 10.2% are men.

As for the age of the participants, the youngest was born in 2008, the oldest was born in 1947. The majority were city dwellers, university employees, museum employees and students.

Interestingly, 57.8% believe that a virtual museum cannot replace a regular one; 26.7% find it difficult to answer and 15.6% believe that they can replace it (Fig. 3). In our opinion, the advantage of visiting museums physically was chosen because there is usually imperfect navigation and exhibition space: a visitor to a virtual gallery, especially when it comes to a 3D tour, moves only in a predetermined direction and cannot always stop in front of an object on the distance he/she needs. The space created by combining several spherical images usually distorts and deforms the image. In addition, very large or small objects are quite difficult to reproduce in virtual space in their real sizes. Virtual and augmented reality partially solve these problems, but the AR function is not integrated into all virtual exhibitions, and not everyone has a VR headset either. In the vast majority of cases, the possibilities of a visitor to a virtual exhibition do not go far beyond the screen of his/her device.

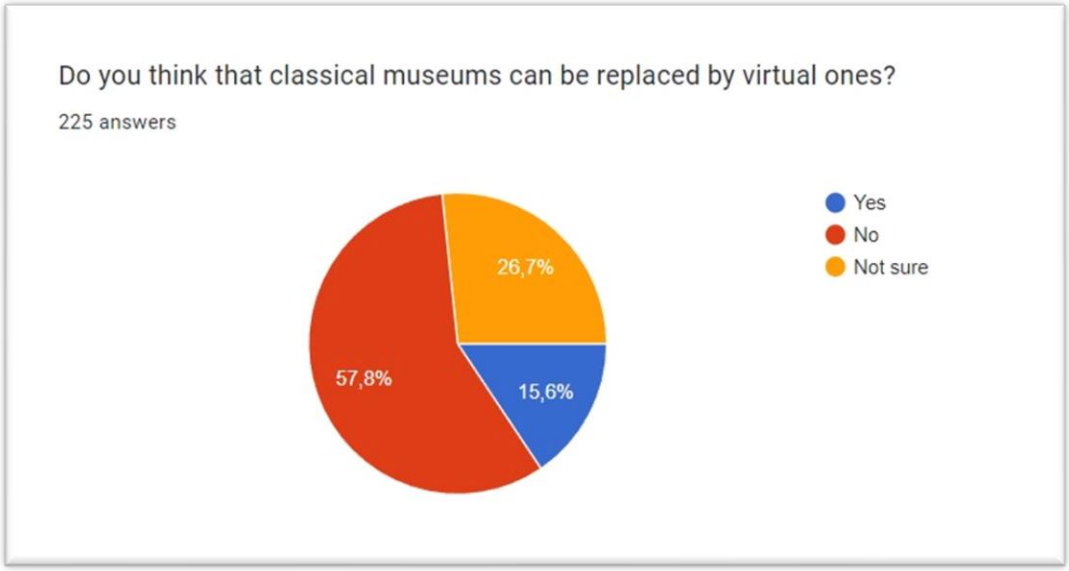


**Figure 3:** Virtual museum & classical museum

At the same time, despite the fact that the majority believes that a virtual museum cannot replace a traditional one, 72.2% are not against visiting a museum without leaving their homes (Fig. 3.). What does this say? In our opinion, due to various circumstances (war, pandemic, distance, lack of time, etc.), preferring offline visits to conventional museums and not being able to do this, an alternative has appeared, so there is such a dissonance in percentages in both cases regarding whether the virtual museum can replace the classical one and wanting to visit the museum without leaving home.

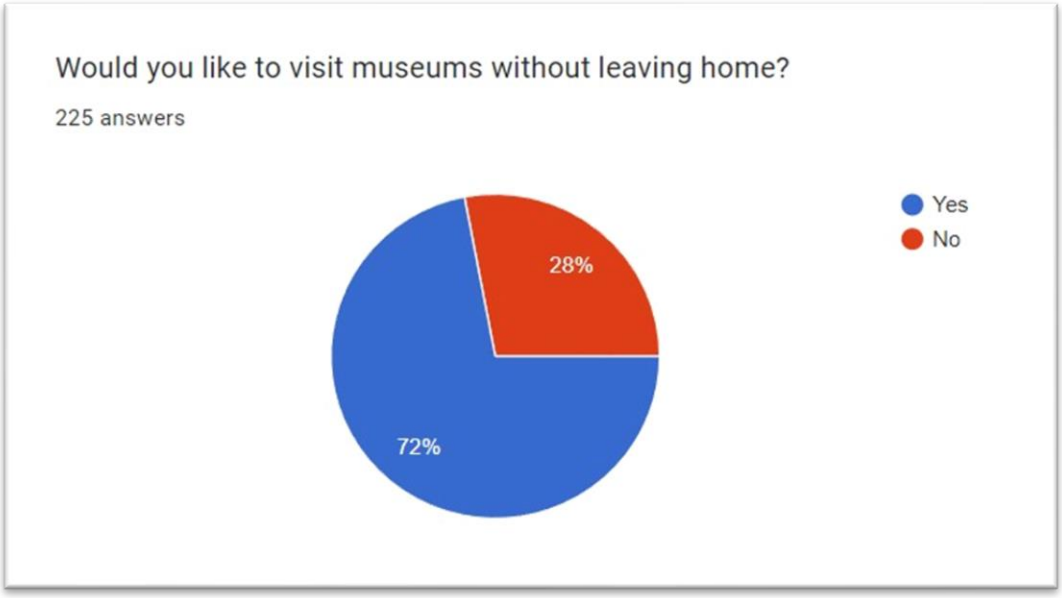


**Figure 4:** The result of participants' answers to the question about the possibility of visiting the museum without leaving home.

In this regard, the result of the participants' answers to the question about the attitude towards the possibility of access to the museum through a phone or PC seems quite logical. Namely, 88% are positive and only 12% are negative (Fig. 5).

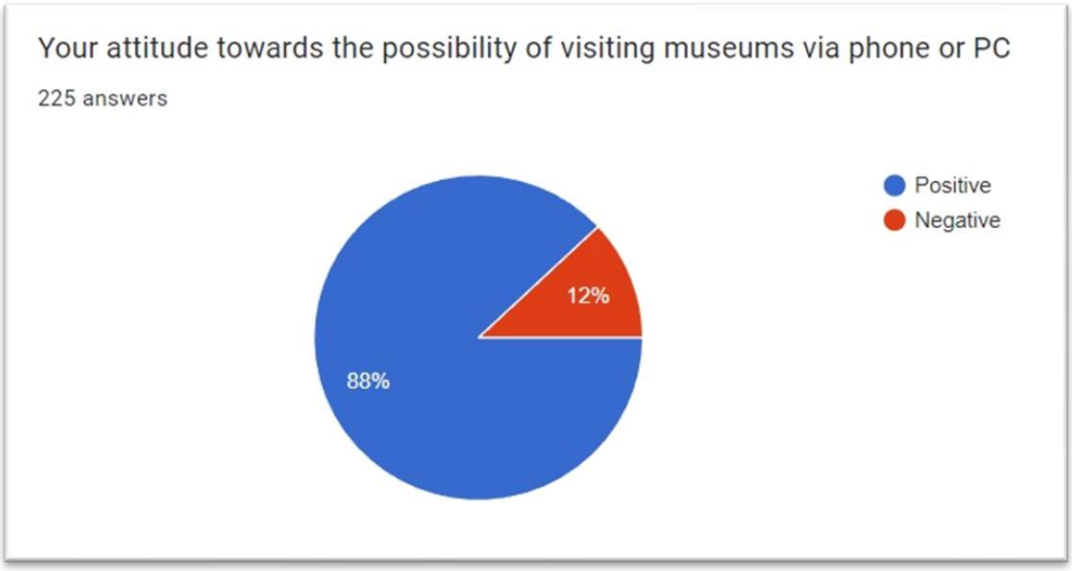


**Figure 5:** Attitudes toward the possibility of visiting the museum via phone or PC.

One way or another, the popularity of virtual museums is growing, as evidenced by the result of the answer to the question whether you would like to learn more about virtual museums: 91.1% would like to learn more about virtual museums, 8.9% would not (Fig. 6).

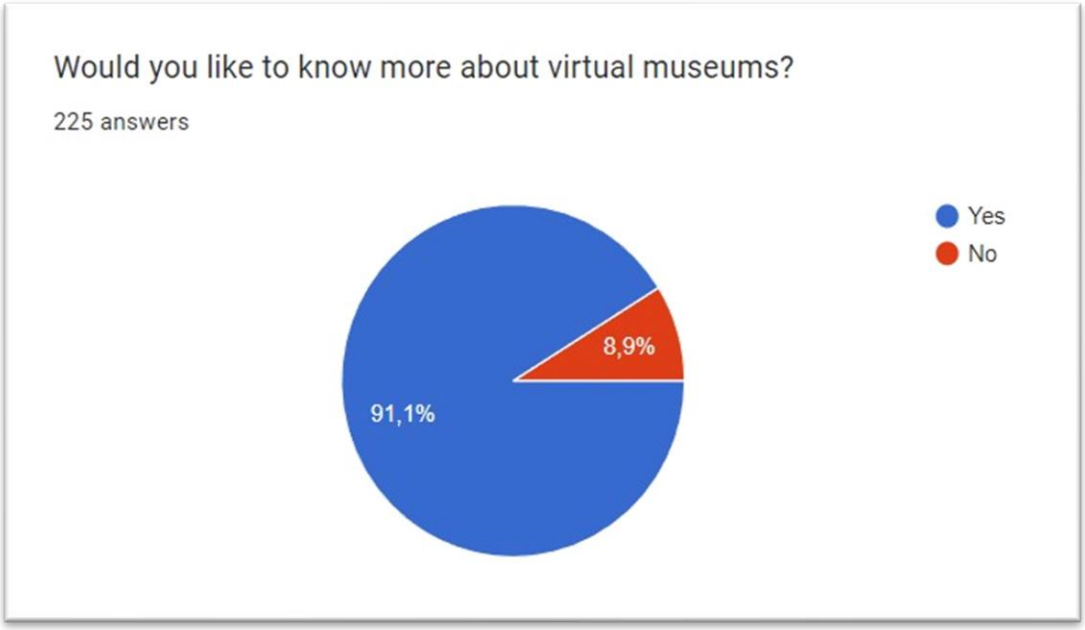


**Figure** 6: The result of answers to the question about the desire to learn more about virtual museums.

Thus, there is no single correct context or environment in which culture can exist. First of all, it should be where there is an audience interested in it. The result of the survey suggests that the audience is interested in virtual museums, wants to visit them in a convenient way, get more information about them. In-person visits to museums are preferred, however, for various reasons, there is no possibility of physical visits and an alternative appears in the form of a virtual museum. An important point is the fact that visiting the virtual museum arouses interest in the exhibits and encourages visiting the physical one. As for the effectiveness of museum communication, it depends primarily on a professional dialogue with visitors.

## 5. Acknowledgements

The conducted study allows us to conclude that that the adoption of innovative solutions, 3D technology, has significantly enriched the communication capabilities of museums. The introduction of interactive projections, 3D images, and 3D scans in the museum industry makes it possible to recreate cultural monuments, their location, and also to make museum visitors familiar with cathedrals, churches, and other historical buildings that have been damaged or destroyed. Digitization provides access to services and obtaining information and knowledge provided by digital technology. The implementation of this principle is possible only in case of introduction of a virtual version of the museum.

Each way of interacting with cultural artefacts, whether physical or virtual, provides a unique, equal experience.

We express our gratitude to everyone who took part in the survey, in particular, teachers and students of institutions of higher and secondary education in Ukraine, museum employees and everyone interested in the development of traditional and virtual museums.

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