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Acceptance of Augmented Reality App among Museum Professionals Case of Vilnius City Museums

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博物館専門職員による拡張現実アプリの受容
ヴィリニュス市立博物館の事例研究

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Abstract

In the late 2010s, augmented reality (AR) smartphone applications were a global trend in museums. Previous studies on attempts to implement AR apps were mainly examined for the benefits to visitors, but one aspect was lacking: how do museum professionals accept them? This study explores the question in the case of the AR app "Daugiau nei matai (hereafter 'DNM')" at four museums under the Vilnius Memorial Museum Directorate in Lithuania's Vilnius City Municipality. The study conducted a comprehensive questionnaire survey of all ten museum professionals involved in the app's implementation, and a short interview with the app developer. The survey results were analyzed from four perspectives including basic usage and impressions, values of DNM, role of museum professionals in development, and advantages/disadvantages. As a result, it was found that museum professionals positively utilize the AR app when they are convinced of its value to visitors.

Keywords: Museum, augmented reality, Lithuania, museum education

Introduction: Augmented Reality in Context of Museum Studies

The use of information and communication technologies in museums has been a dominant and growing topic in museum studies over the last couple of decades. This usage has a global trend that is dependent on technological innovation and other factors. In the late 2010s, augmented reality (AR) smartphone applications were the trend, due to the rapid dissemination of smartphones worldwide[2]. This paper explores the question, "How do museum professionals accept augmented reality guidance for visitors?". The author

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conducted a case study in 2018 on Vilnius City Museum, which released the smartphone app, "Daugiau nei matai (hereafter 'DNM')", in 2017.

Augmented reality (AR) is a technology that adds digital content by overlapping it with the real world, which is displayed on smartphones or other specific equipment. More specifically, Schueffel (2017:2) defined AR as,

> An enhanced version of physical real-world reality, in which elements are superimposed by computer-generated or extracted real-world sensory inputs such as sound, video, graphics, or haptics.

The first idea emerged in the late 1960s, and its usage has broadened, including in the military, space science, and entertainment, since the end of the last century (Schmalstieg and Hollerer 2016).

AR has become popular because of the widespread use of smartphones. Museums have also started to develop smartphone AR apps for visitor guidance in the Tokyo National Museum, National Museum of Singapore, and National Museum of Natural History in the United States (Tokyo National Museum n.d.; National Museum of Singapore n.d.; Smithsonian National Museum of Natural History n.d.). Apps are downloadable for individual smartphones; therefore, museums no longer have to lend visitor equipment.

Previous research related to AR apps has two perspectives: technology- and visitor-oriented. Technology-oriented studies have aimed to develop an AR system for museums or prototypes to solve the challenges of existing systems. For instance, Kim and Park (2011) proposed an attempt to improve the limitations of sensors, and Wang (2018) sought to strengthen the indoor positioning and recommendation functions.

On the other hand, visitor-oriented studies have aimed to improve visitor learning experiences in museums. For example, Yoon and Wang (2014) clarified AR learning in a science museum, and Kyriakou and Hermon (2019) attempted to enhance the experience of children by combining a 3D model and a head-mounted display using AR. Moreover, Tom Dieck and Jung (2017) examined the value of an AR app in museums from various perspectives.

Previous studies have shown that efforts by large national-level museums stand out, and the perspective of how museum professionals use these apps is lacking. Thus, this study focuses on relatively small museums and their attempts to implement AR apps, especially how museum professionals accept them. The author selected an app "DNM" at the Vilnius City Museum in the Republic of Lithuania. Primary data were collected through a questionnaire and short interviews to explore the acceptance of the app by museum professionals.

The remainder of this study is structured as follows. The next section "Background" will briefly explain the case of this study, a smartphone app "DNM" ("more than

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[2] The author originally wrote this paper in 2018, and submitted to an online journal in February 2019. However, the journal ceased publishing new issues in 2019 (as of April 2024, the latest issue was in 2018). She waited her paper's review for five years, and requested the withdrawal of her paper from the journal on April 1st, 2024. On the same day, she received an answer from the editorial department that her withdrawal was accepted. Although, this paper discusses the acceptance of the latest technology by museum professionals, it is still relevant for museum studies in 2024. Thus, the author decided to publish this paper in the *Research Bulletin of Obihiro University*. To adapt this paper to the contemporary research context, the author looked it over and made corrections.

you see," in Lithuanian). The following "Methodology" section will display the data collection method used in this study: a questionnaire and a short interview. Subsequently, the "Finding" section will first show the results of the questionnaire as graphs and the result of the interview as a table. The results were analyzed from four perspectives. Finally, the "Discussion and Conclusion" sections discuss the findings and summarizes the paper.

Background: Smartphone App "Daugiau nei matai"

On November 3, 2017, Venclova's House Museum's YouTube channel posted a short film that promoted the smartphone app "DNM" (Venclovahouse 2017). The film revealed that the DNM is available in four museums: Venclova's House Museum, Vincas Kreves- Mickevicius Memorial Flat Museum, Vincas Mykolaitis-Putinas Memorial Flat Museum, and the Beatrice Grinceviciute Memorial Flat Museum (ibid.). About two weeks later, on November 15, the Faculty of Communication of Vilnius University announced the release of the app on its website (Komunikacijos Fakultetas 2017). As of April 3, 2024, DNM was still available on Google Play Store (Google n.d.). This section briefly summarizes the basic information of the four museums and demonstrates how DNM works.

The four museums listed above are owned by the Municipality of Vilnius City and are all under the Directorate of the Vilnius Memorial Museum (Vilniaus memorialinių muziejų direkcija). Each museum is a memorial of Lithuanian cultural figures, as their titles show, located in the places

Table 1. Four museums under Directorate of Vilnius Memorial Museum

Lithuanian title / English title	Abbreviation	Address
Venclovų namai-muziejus / Venclova's House Museum	V	Pamėnkalnio g. 34, LT-01114 Vilnius
Vinco Krėvės-Mickevičiaus memorialinis butas-muziejus / Vincas Kreves-Mickevicius Memorial Flat Museum	K	Tauro g. 10, Vilnius LT-01114*
V. Mykolaičio-Putino memorialinis butas-muziejus / Vincas Mykolaitis-Putinas Memorial Flat Museum	P	Tauro g. 10, Vilnius LT-01114*
B.Grincevičiūtės memorialinis butas-muziejus "Beatričės namai" / Beatrice Grinceviciute Memorial Flat-Museum	B	A.Vienuolio 12 – 1, Vilnius LT- 01104

* Vincas Kreves-Mickevicius Memorial Flat Museum and Vincas Mykolaitis-Putinas Memorial Flat Museum are placed at the same address, but on different floors and in separate venues.

Table 2. Statistical data of four museums under Directorate of Vilnius Memorial Museum (2017)*

Abbreviation (i.e. Table 1)	Number of staff	Number of exhibits	Number of annual visitors	Area of exhibition halls (m2)
V	2	13136	3301	31.95
K	3	3241	3456	95.8
P	2	5793	3655	41
B	3	2955	2584	29.23

* The statistical data in the chart refer to the official data published by the Ministry of Culture of the Republic of Lithuania. The statistics for Lithuanian museums are downloadable directly from the Ministry's website (Lietuvos Respublikos Kultūros Ministerija 2023).

where the figures lived. Museum details are listed in Tables 1 and 2. As statistical data in Table 2 shows, all four museums are small in terms of workers, space, and collections.

The development of DNM is according to the project "Implementation of technological innovations and their impact study in Vilnius Memorial Museums" (Technologinių inovacijų diegimas ir jų poveikio tyrimas Vilniaus memorialiniuose muziejuose [in Lithuanian]) (Lietuvos nacionalinis dailės muziejus 2017). Paveldo Komunikacija developed the app (Google n.d.). The Faculty of Communication at Vilnius University, which announced DNM's release on its website, provided the technological cooperation for this project.

DNM is provided for free only in Google Play Store. Anyone that has a smartphone that can download the app via Google Play Store can install it on their device (Google n.d.). However, the main function of DNM is for using in the four museums mentioned above. DNM has four functions: augmented reality, instructions, map, and general information. All functions are accessible from the first view of the app (Fig. 1, left).

Augmented reality (Papoldyta realybė)

This is the primary function of DNM. When a user pushes the button on the first view, the smartphone camera starts, and the user can see almost the same view on the display as the user sees it directly, as when one uses a camera app. When the app detects the AR markers, the DNM displays the corresponding digital content. The AR markers in this app are objects in the exhibition room, such as bookshelves or paintings on the walls. The content included photos, manuscripts, 3D objects, and voice and video recordings. The middle and right figures in Fig. 1 show a comparison of a simple photo and the app view at the Vincas Mykolaitis-Putinas Memorial Flat Museum.

Instruction (Instrukcija)

This is a supplementary function of this app, which shows users how to use the app.

Map (Žemėlapis)

This is also a supplementary function of the app, which leads users to the venue. When a user pushes the button, the

*Fig.1 (Left) First view of app (screenshot by author), (Middle) View of app in same venue (screen shot by author), (Right) Photo in Vincas Mykolaitis-Putinas Memorial Flat Museum (photo by author).

* All photographs and screenshots were permitted by Directorate of Vilnius Memorial Museums.

screen is transferred to a map app that shows the location of the four museums.

General information (Apie)

Thus, the function aims to provide users with general information about the four museums. The information includes opening hours, logos, brief descriptions, addresses, email addresses, telephone numbers, and links to Facebook pages.

Methodology

The data collection methods used in this study were a questionnaire and short supplemental interview. The primary aim was to collect data on how museum professionals accepted and worked with DNM. The author conducted the questionnaire with ten museum professionals at the four museums, as shown in Table 1. She directly distributed and collected the printed question lists from August to September 2018. The question list consisted of five sections: general usage of DNM, usage in educational programs, values/ comfort, plans, and roles in development (Table 3). Notably, to examine the value of the app, the author included the five AR values of Diek and Jung (2017). The questionnaire was written in Lithuanian. In further sections, free-description answers written in Lithuanian were translated into English by the author.

Additionally, the author conducted a short interview with a DNM developer at Paveldo Komunikacija to examine the role of museum professionals during the development phase of the app. This interview was intended to clarify the workflow of DNM development and the roles of developers and museum professionals in each stage. The interview was not recorded. The workflow for developing the DNM was formed according to the interview, and the interviewee verified it via email.

Table 3. Question list for Questionnaire Survey

No.	Question	Answer Method
1	General usage	
1-1	How do you usually use DNM, when you guide visitors?	Multiple options 1) I use as the main tool 2) I use as a supplementary tool 3) I don‘t use, but introduce it to visitors 4) I don‘t use nor introduce
1-2	How do you introduce the app to visitors?	Multiple options (Multiple choices allowed) 1) I explain directly to visitors 2) I give a written explanation 3) A written explanation is on the wall 4) Via website or social network service How often? (More than once a week / several times a month / several times since the app release) 5) Other
1-3	What do you explain when you show the app to visitors?	Multiple options 1) Instruction on how to use it 2) About its contents in detail 3) Other

1-4	How often do you see visitors who know about the app in advance?	Multiple options 1) Several times a week or more 2) Several times a month 3) Several times since the app release 4) Never
1-5	How did visitors react to the app? Please explain.	Open ended answer
2	Usage in educational programs	
2-1	Please list current educational programs at your museums.	Open ended answer
2-2	Do you have any educational program which utilizes smartphone or tablet computer? If yes, please list them	Open ended answer
2-3	Do you have any educational program which utilizes the app? If yes, please list them.	Open ended answer
3	Values/comforts	
3-1	What are the advantages of the app for you?	Open ended answer
3-2	What are the disadvantages of the app for you?	Open ended answer
3-3	Did you have any technical problem with the app? If yes, how did you solve it?	Open ended answer
3-4	Which of below are values of the app do you think? Why?	Multiple options (Multiple choices allowed) 1) Economical value 2) Social value 3) Historical and cultural value 4) Educational value 5) Experiential value 6) Othe
4	Plans	
4-1	Do you intend to use the app furthermore?	Multiple options 1) Yes 2) Yes, but it would be better to have something different 3) Other
4-2	When the app become unavailable due to technological reasons, are you going to create new app?	Multiple options 1) Yes, I want something similar 2) Yes, I want something newer 3) No, I don't think I need 4) Other
5	Roles in development Were you involved in the app development? If yes, please answer to questions below.	
5-1	What was your role at development?	Open ended answer
5-2	How did you select the contents for the app?	Open ended answer
5-3	Do you think that the app satisfies your expectation? Why or why not?	Open ended answer

Findings

This section analyzes the survey results from four perspectives. Prior to the analyses, the author aggregated the responses to the questionnaire. She aggregated responses to questions with multiple options as quantitative data and formed seven graphs to display the results (Figures 2–8). Open-ended answers and miscellaneous answers from multiple options were translated from Lithuanian to English and analyzed accordingly.

A short interview was conducted to verify the process of developing the DNM. The interview was conducted on August 7, 2018, from 4.00 pm to 5.00 pm. The results of this interview are the workflow of the DNM development. The author prepared a table to summarize the results (Table 4).

In the following sections, the author analyzes the survey results from four aspects: basic usage and impressions (Analysis 1), values of DNM (Analysis 2), the role of museum professionals in development (Analysis 3), and advantages and disadvantages (Analysis 4). All figures and a table will appear in the section that analyzes the involvement of museum professionals in app development.

Analysis 1: Basic usage and impressions

This section focuses on museum professionals' basic usage and perceptions of DNM. In the questionnaire, respondents answered questions related to their usage of and impressions of DNM (Question number 1-1, 1-2, 1-3, 1-4, 1-5, 4-1 and 4-2). Thus, analyzing how they perceive the system might provide good clues for understanding the overall usage of DNM in museums.

Most museum professionals use the app as a supplemental tool rather than a primary tool. Figure 2 shows the responses to question 1-1 "How do you usually use DNM when you guide visitors?" The responses imply that some respondents did not use the app, but still told visitors that they had it.

Another aspect of app usage is how museum professionals convey DNM information to visitors. Figure 3 displays responses to Question 1-2, which is about how museum professionals tell information about DNM. According to the results, all professionals who used or introduced the app had direct interaction with visitors. Moreover, both analog means (handouts) and digital means (via the internet) were adopted. In terms of digital communication, its frequency varied; four of them shared information about the app several times a month and another respondent several times since the start of the app. Moreover, Figure 5 shows that some respondents rarely noticed visitors who were already aware of DNM before their visits. It seems that online communication was not successful for the dissemination of DNM.

When visitors entered their museums, professionals directly explained the app. Figure 4 shows details: the majority is "telling how to use it," and "telling in detail about the app." Furthermore, miscellaneous responses are: "all the processes how to use practically" and "Explain by words." These free-description answers could be classified as "telling how to use it'." Thus, most respondents made an effort to publicize the app itself, but did not actively explain how to use it.

The survey also revealed the respondents' perceptions in the context of continuity. Figures 6 and 7 show the answers to questions concerning further use of the app. In short, DNM might be the best tool, but they tend to seek something more advanced in the future. Furthermore, the answers to Question 4-2 provide a wider perspective of technology and museums. Respondents wrote "We continually renew [our] education programs. In the future, there will be [something for] the visitor's needs," and, "I will not be at work. According to the app developer, the duration of the app is between two and three years, and it is possible that the app will be completely unusable owing to the advancement of the devices." This shows that professionals work on museum principles that

do not always correspond to the calendar of technological innovation.

The questionnaire revealed that the app was a supplemental tool for museum professionals and was provided directly to visitors. However, visitors are not actively invited to use the app. In other words, the app does not function as a tool to improve the efficiency of work or advertising. Moreover, the app could be useful for professionals who wish to use it continuously. Nonetheless, the difference in the time spent in museums and technological innovation may obstruct the renewal of apps in the future.

Fig. 3 Result of Question1-2 “How do you introduce the app to visitors?”

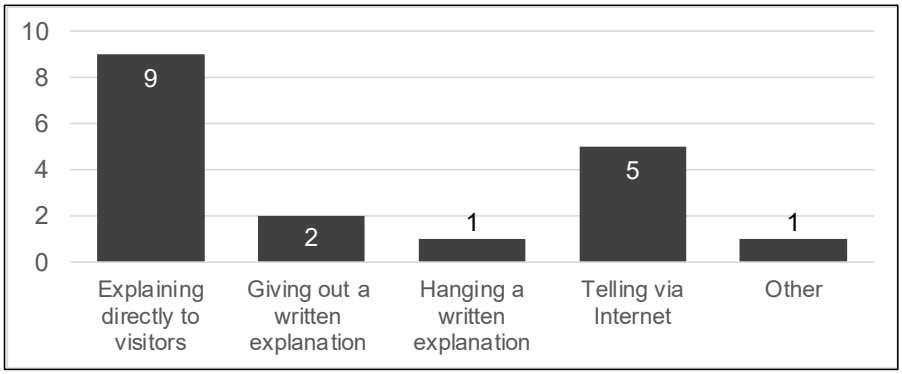


Fig.4 Result of Question1-3 “What do you explain when you show the app to visitors?”

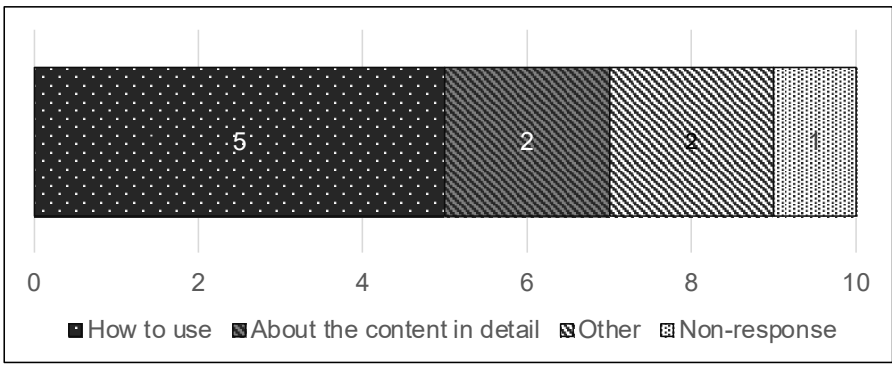


Fig. 5 Result of Question1-4 “How often do you see visitors who know about the app in advance?”

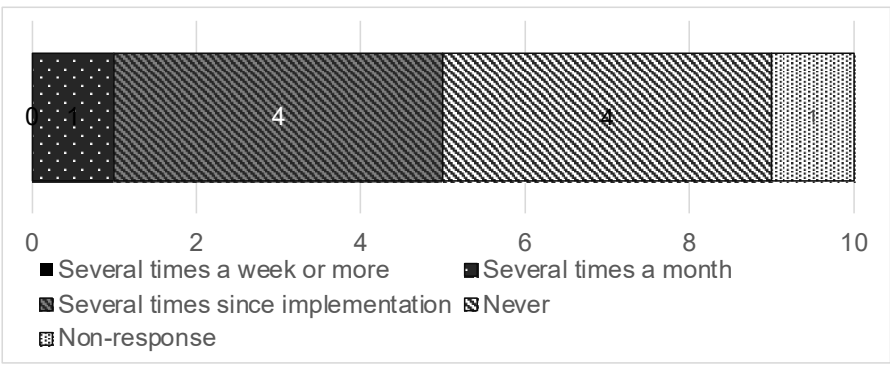


Fig. 6 Result of Question 4-1 "Do you intend to use the app furthermore?"

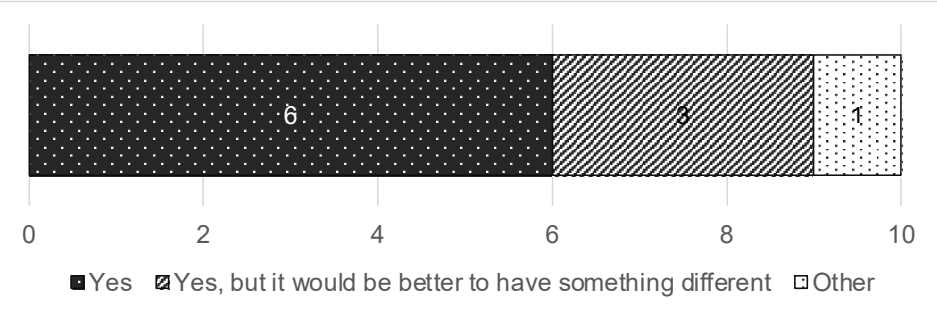


Fig. 7 Result of Question 4-2 "When the app becomes unavailable due to technological reasons, are you going to create new app?"

Analysis 2: Values of DNM

This section considers the values of the app DNM, referring to the AR app value listed by Diek and Jung (2017) from a focus group study. In the discussion of Diek and Jung (2017), they took into account all internal and external stakeholders, except for museum workers who introduced the app to visitors. Diek and Jung (2017) list six values using a stakeholder approach.

(1) Economic value: financially viable for a museum
(2) Experiential value: interactive and enjoyable for visitors
(3) Social value: leading to personal fulfillment and makinbf an impression
(4) Historical and cultural value: letting visitors recognize the historical and cultural value of a museum
(5) Educational value: enhancing visitor learning and educational experience
(6) Epistemic value: provoking strong interest in the potential of AR

The question on the value of the app, Question 3-4, includes the values from (1) to (5) above and "other." Each value was not explained in the questionnaire; however, the respondents were asked to explain the selected values. This study excluded (6) epistemic value from the questionnaire. This value was set to examine the potential of an AR app, since Diek and Jung's (2017) case was a museum before starting to use an AR app. However, this paper focuses on museums that have already started using AR apps, so epistemic value is not applicable. Figure 8 summarizes the responses to Question 3-4. The following paragraphs analyze each value from the free-description answers.

Economic value: None of the respondents selected

an economic value. One commented that "The museum is free of charge, there is no such [value]." All four museums using the app were free of charge and their income was mostly dependent on the budget of the Vilnius municipality. Therefore, the economic value of the apps was irrelevant to the respondents.

Experiential value: In terms of experiential value, museum professionals stated that the app changed visitor perspectives. The app "let [visitors] see the exhibition from another angle," so that "When visitors use the app, they look around the museum differently." Moreover, DNM "let [visitors] have an emotionally engaging experience." Also, as an advantage of technology, "for older people, 3D is still impressive."

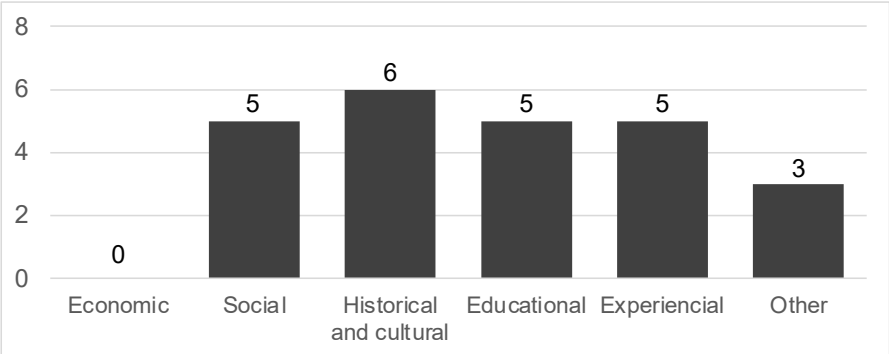
Social value: The majority of respondents thought that the AR app was socially valuable but from different perspectives. One is encouragement of communication, that "the program [the app] stimulate to communicate," and that it "communicate and share outreach education." In this context, communication refers to interactions between museums and visitors. Moreover, the app appears to "help to attract younger visitors [and] family," and to be an option for people "who have a disability." These responses suggest that DNM expanded the range of visitors. Further, the app adds the option for visitors, that they "can individually think about the exhibition, that is interesting for him/her." In short, the DNM expands the possibility of museums attracting visitors.

Historical and cultural value: For respondents, this value indicates the possibility of showing more hidden materials and information. For instance, DNM shows "many facts, which guides do not disclose," and "surrounding information of a museum." More importantly, it uses "many authentic and historical sound and visual records." They emphasized the historical and cultural value of the app itself for highlighting the historical and cultural value of a museum.

Educational value: The educational value for visitors is that they gain new knowledge. Since the nature of DNM is "informative, understandable for various generations," it enables visitors to "know about a [cultural figure] in a short time." It is applicable for younger visitors, that "students can especially have a wider knowledge of the creation of a [cultural figure] and the period that a [cultural figure] lived," and even "teachers offer ideas for a new educational program." This value is an extension of learning through DNM.

Miscellaneous: Some respondents wrote in the "Others", but most were categorized into the six indicated values. Only

Fig. 8 Value of the app: Result of Question 3-4



one response was literally miscellaneous, that said, "modern museum is clearly formed." This implies abstract value, that the app made the museum "modern" in general.

Summary: The overall answers showed that the app values were for museum visitors. Four (or five?) values–experiential, social, historical, cultural, and educational–were related to visitor merit. However, economic value was not recognized because museums are free of charge. They implied that, in terms of DNM value, the goal for the respondents was to increase the number of visitors as well as potential visitors.

Analysis 3: The role of museum professionals at development

How is it possible to develop a smartphone application for museums with a small number of professionals? This section will reveal the answer through the results of both the questionnaire and short interviews. First, to gain developer-side perspective, the overall workflow was discussed, based on the interview, which is briefly summarized in the Table 4. Museum professionals' responses then consider the museum-side perspective.

From the developer's perspective, the overall process of developing DNM took approximately one year from the first plan to publishing for visitors. App development began with museum professionals' understanding of the nature of the app: What can be done and what cannot be done? The preparation was then initiated. At this stage, both developers and museum professionals considered the app content because it mainly relied on the knowledge of professionals expressed at this stage. AR markers were also considered in this phase, which involve identifying objects as potential markers. After preparation, the developers worked on content creation and programming. Similar to other types of app development, testing app usage was required before completion.

Responses to the questionnaire revealed the perspectives of museum professionals. Four respondents responded to the questions regarding their roles during the development phase. The central role the professionals played was "content creation," which included "educational" program content. They have already considered how to utilize it during the development phase. To prepare content for the app, professionals referred to "contents of museum archives" and "the facts of [cultural figure's] life and creation." Even one respondent answered that "I thought of ten themes from [cultural figure's] life and creation" to prepare the contents. Therefore, the AR app not only shows what is hidden in the collection storage room, but also provides supplemental

Table 4. Workflow for developing the DNM.

	Museum professionals	Developer of app
1. Introduction	Museum professionals understand the possibilities and limits of app	Developer explains to museum professionals possibilities and limits of app
2. Preparation	- Museum professionals propose possible contents for the app which is in the museum - Look for objects which could be AR markers with the developer	- Look for objects which could be AR markers with museum professionals
3. Creation	Waiting for completion	Developer prepares contents, and creates app
App completion		
4. Operation	Museum professionals use app in each museum	Developer update and app repair

materials for visitors to better understand the museum.

Although professionals participated in app development, there were some challenges in the finished DNM product. One wrote there were "constant failures and freezing," and another wrote "almost" satisfying, but added that "we wanted more 'hidden points' [AR markers]." Another answered, "We have to try more to communicate with teachers and offer educational [programs] which uses DNM (Daugiau nei matai)." For these professionals, the app fulfilled their requirements; however, further possible advancements are mentioned.

Although the developers thoroughly performed the technologically specialized part of the app development, the details of the app seemed to depend on the museum professionals. They created not only content in the system, but also their usage in the exhibition room. As a finished product, the critical part of DNM follows the expectations of professionals, although there is still a need for improvement.

Analysis 4: Advantages and Disadvantages

All systems have both positive and negative features behind their positive features, and DNM is no exception. To understand how museum professionals accepted DNM, they grasped both the better and weaker points of the app that they noticed. On one hand, the advantages revealed from Question 3-1 are that DNM is impressive and, to date, enables self-guided tours and provides more knowledge. On the other hand, the disadvantages of Question 3-2 and 3-2(?), show problems with the app itself, lack of tablets, lightning in the exhibition room, and anxiety. Further paragraphs will discuss them in more detail with quotes from free-description responses.

Advantages: The first advantage is that DNM is interesting to visitors. One wrote that it is "interesting wither for young and adult [visitors]," showing a wide range of acceptance. Other respondents reported "attraction to younger visitors," and "Elementary school pupils, even up to ninth grade, like it very much." Moreover, DNM "attracts visitors, especially teachers with students," and the function of extending education in the museum could be apparent to professionals. This is interesting, especially in the context of educational use.

As a "new technology," the smartphone app is also an advantage. One stated that "the largest advantage is the AR experience," reflected in another respondent's words "A new usage of media." DNM as an AR in museums is new for visitors. In addition, current technology enables self-guided tours in exhibition rooms for visitors. A professional explained that the app is "comfortable for visitors to use because they do not have to listen to a guide, and they can learn by themselves'."

The responses also mentioned the advantage of the app's main feature: it extends the exhibition room and provides more information. Thus, it is "convenient to know more about [cultural figure's] creation." More directly, the app "visually adds information, let museum to have more possibilities" that museum "combine the old (memorials) and the new (the app)." In short, this application expands what is currently available in museums as a merit for museum professionals.

The advantages show that DNM is interesting and can attract visitors to their exhibitions. The respondents appeared to be interested in two types of advantages: outreach and deepening one's knowledge. Overall, the advantages of the app for museum professionals in this study may be rephrased as advantages for visitors and potential visitors.

Disadvantages: The most dominant disadvantage of DNM is its technological shortcomings. Significant problems in museums are partial or fundamental. The former issue is that the app "doesn't trace mark points [AR markers]," or "doesn't catch signal." Another issue with this application is that the operation ceased. Some mentioned this problem as "Sometimes the tablet freezes," and others mentioned as

"Sometimes the program [app] freezes."

Another problem arises from the lack of hardware, tablet computers, that "tablets are lacking, because we have only one." DNM is downloadable for an individual's smartphone, but since it is often used in educational programs for groups of students, sometimes visitors do not have a smartphone compatible with DNM. Even some visitors "do not want to install the app because it takes up a lot of memory." Thus, "Visitors who have their own telephone [smart phone] is necessary" for them to offer "Daugiau nei matai."

Another disadvantage of AR is its compatibility with museums. First, museums have a low level of illumination in the exhibition rooms, that they feel "Lighting is lacking," and it "influences the work of the app." The museums were initially ordinary flats or houses, so one person thought that DNM "doesn't fit memorial surroundings," since the museums are an authentic space which is preserving the place where cultural figures lived. Another thought "uncomfortable to find a place and points where reacts [AR markers]." These facts suggest that museums may not be the best venue for using the AR app.

The disadvantages showed that DNM has technological issues that prevent visitors from using it and also does not fully fit memorial museums. These disadvantages were not mentioned in previous studies, perhaps because the data were biased; pro-app professionals were involved in the studies. However, they are challenges to overcome, but not a fatal feature, to stop using DNM.

Summary: This section discusses the advantages and disadvantages of the DNM app as recognized by museum professionals. Both advantages and disadvantages consider benefits to visitors. In other words, the respondents were pursuing a better experience of visitors in their venue, and DNM was helpful in achieving that goal, but there were also some shortcomings.

Discussion and conclusion

This paper presents a case study of an AR app DNM implemented in Vilnius City museums in the Republic of Lithuania. In 2018, the author conducted a questionnaire survey and a short interview. The previous section analyzed the survey results from four aspects. They are basic usage and impressions, values of DNM, role of museum professionals in development, and advantages/disadvantages. The following discussion aims to answer the primary question of this study: How do museum professionals accept augmented reality guidance for visitors?

Museum professionals in the four museums either accepted the AR app as a supplemental tool or actively recommended it to visitors. Some museum professionals were involved in the app development and content preparation. The advantages they remark are mainly something worthy of visitors and a potential vision of outreach for general and deepening experiences. Similarly, the disadvantages include obstacles for visitors, mainly technological shortcomings, to use the app comfortably. The general attitude of museum professionals toward the app can be described as forward-looking.

The respondents perceived four (five?) values of DNM: experiential, social, historical, cultural, and educational. Social values match the advantages of outreach. In addition, experiential, historical, cultural, and educational values match the advantages of deepening experiences. The value of the AR app by Diek and Jung (2017) mirrors its advantages.

Therefore, the app serves primarily as a merit for museum visitors. In other words, the merits of museum professionals have not been identified. Whether museum professionals, especially those who directly interact with visitors, understand, use, and recommend directly affects visitors' access to new possibilities; museum merits are perhaps crucial for users. However, the respondents did not express inconvenience; therefore, visitor-oriented app

development was not a problem in this case.

A limitation of this study is that visitors' perspectives were lacking, as it focused on museum professionals. Museum professionals observed the visitors' advantages and values discussed in this article. Therefore, further studies on visitors are required to verify whether professional assumptions and visitors' feelings correspond. However, this study aimed to examine how museum professionals perceive the AR app; therefore, this limitation does not influence the nature of this study.

Consequently, museum professionals positively utilize the AR app when they are convinced of its value for visitors. Although some issues remain that prevent museum professionals and visitors from using the app, it is collectively conceived as useful for visitors. Despite its positive and negative technical features, they may accept any AR app similar to DNM and utilize it when they admit that it is useful for visitors.

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Conflict of Interest Declaration

The author declares that she has no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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摘　要

2010 年代後半、拡張現実（AR）スマートフォンアプリの導入が、博物館において世界的な流行した。AR アプリ導入の試みに関する先行研究は、主に来館者の利便性を関するものであったが、博物館の専門職員が AR アプリをどのように受け入れているのか、という観点が欠けていた。本研究では、リトアニア・ヴィリニュス市のヴィリニュス記念博物館管理局所管の 4 館の博物館における AR アプリ「Daugiau nei matai（ドウギョウ・ネイ・マタイ、見るよりももっと多く、という意）」の事例において、この問いに基づき調査を行なった。調査としては、アプリの導入に関わった 10 名の博物館専門職員全員を対象とした悉皆アンケート調査と、アプリ開発者へのインタビュー調査を実施した。調査結果は、基本的な利用方法と印象、DNM の価値観、開発における博物館専門職員の役割、利点・欠点の 4 つの側面から分析された。その結果、対象事例において博物館専門職員は、AR アプリが来館者にとって価値があると判断し、活用していることがわかった。

キーワード：博物館， 拡張現実， リトアニア， 博物館教育