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Enhancing historical tours for older adults with augmented reality technology a case study

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Abstract

Background: Research in Japan shows that the older people get, the more they look forward to traveling as a way of life in their old age, and among those who have traveled domestically and internationally, those in their 60s and 70s account for a large percentage, which has a significant economic impact on the travel industry. Kure City in Hiroshima Prefecture is aging and has a declining population. Still, it was once an important center for the rapid development and dissemination of advanced science and technology throughout Japan. The authors, in collaboration with industry and academia, planned a boat tour using augmented reality (AR) technology to help visitors rediscover the history of Kure Bay. The tour was incorporated on a trial basis into some of the historical exploration tours of the Kure area offered by a major travel agency from the Tokyo metropolitan area and other major cities and was conducted five times.
Objective: Although participants were assumed to be men and women in their 60s when the plan was formulated, most participants were older, ranging from their late 60s to 80s, with the oldest in their 90s. Approximately 30% of the initial participants complained in the post-program questionnaire that they found the AR equipment difficult to use and could not see. Therefore, this study aimed to explore what improvements and support would satisfy the older participants.
Methods: In the second and subsequent trials, changes were made, such as replacing the explainer, reducing the equipment used, and changing the explanation method. The total number of valid responses for the five trials was 83.
Results: Complaints decreased after the third session when staff familiar with older people were also familiar with the equipment, and the explanations were more concise. Also, after the fourth session, when the equipment was made more succinct, the desired price, assuming a charge, was statistically significantly higher than before the third session.
Conclusion: Although we are still determining what caused older people to fail to operate the system, staff accustomed to dealing with older people provided concise explanations and friendly operating assistance, which reduced the frustration caused by their failures. In addition, by reducing the number of devices, making the AR content appear larger, and showing the university's involvement, the enjoyment and satisfaction of the project increased, and the desire to use it increased even more.

Keywords: leisure, tourism, AR technology, usability, questionnaire survey

Introduction

In October 2018, the Japan Association for Financial Planners published the results of a survey on life and money among men and women in their 20s to 70s. This article says that people in their 20s want to spend time with their partner when they're old, and people in their 30s and older want to travel. Leisure came in first. 58% of 60-year-olds and 60% of 70-year-olds said they look forward to traveling and leisure activities more as they age.

JTB Tourism Research & Consulting Co., a leading travel agency, released a survey on travel conducted in December 2018 with participants in their 20s to 70s. Of the 7,385 respondents who had traveled within Japan in the past year, those in their 60s and 70s together accounted for 27%; of the 4,576 respondents who had traveled abroad, those in their 60s and 70s together accounted for 21%; unlike people in their 20s to 50s, they avoided the busy summer season and avoided large cities. They must go to places they like because they do not have to change their plans to suit their school-age children (Yomogida, 2019).

According to the annual survey of travel and tourism consumption trends conducted by the Japan Tourism Agency, the unit price of lodging trips for men and women in their 60s to 70s was higher than that of other age groups in the Fiscal Year 2023 at the Corona Ming (Japan Tourism Agency 2024). These results indicate that older

people much enjoy leisure travel and has a significant economic impact on the travel industry.

On the other hand, leisure travel is a relatively new research topic in Gerontechnology; Ho & Lu (2014) concluded that the factors that enhance ecotourism satisfaction for older people are the involvement of the external environment, such as chairs, information boards and guides as an important medium, feelings of nostalgia, and narrative aspects such as the use of senses accompanied by stories of daily life, learning new knowledge, and sharing mechanisms, they concluded. Ishihara et al. (2016) conducted a questionnaire survey among tourists visiting the Yamato Museum in Kure City. They found that tourists under 65 visited the museum for various activities and expectations, such as cycling and visiting sacred sites for TV dramas and anime. On the other hand, they found that tourists over 65 had three main objectives: Self-involvement, visual experience, and historical visit and relaxation.

VR and AR have been widely applied to tourism in Japan and around the world, but there are few empirical studies on both older people and virtual tourism using VR or AR. Srifer (2018) found that participants experienced excitement and engagement during VR sessions, and that similar feelings to actual travel were elicited, but concerns were also raised about unfamiliarity with the equipment and discomfort with camera movements. Yu et al. (2023) reviewed the literature on the impact of VR and AR on enlivening the experience of older tourists, conducted interviews with a group of experts in South Korea, and analyzed an internet survey of older people interested in AR/VR travel. As a result, they concluded that the physical presence of objects in virtual space, conceptual understanding of the tourism content provided, interactivity with the virtual environment, and stimulation of the travelers' senses lead to psychological responses such as anxiety, curiosity, and anticipation, are perceived as benefits, enjoyment, and willingness to revisit by older tourists. From the perspective of Gerontechnology, how can technology be used to encourage the activity of older people and promote unique history and local culture to increase the satisfaction of travel planning?

Background

The tour project discussed in this paper began in May 2022, when the authors, consisting of a computer graphics artist living in Hiroshima (Konishi), his friends, university faculty members (Shigekazu Ishihara and Keiko Ishihara), and the marketing department staff of a hotel along Kure Bay (Kuramoto and his colleagues), met to discuss the creation of a new tourism plan for Kure City. The project began as follows.

Kure in Hiroshima Prefecture, Japan, is currently experiencing an aging and declining population. Still, it was once an important center for the rapid development and dissemination of advanced science and technology throughout Japan. From the Meiji era (late 1800s), the largest naval arsenal in Japan was established in Kure Bay, along with the former Imperial Japanese Navy's Chinjufu Office, and many naval vessels were built there. It is estimated that 48 ships were anchored in Kure Bay at the time of the U.S. military air raid on Kure in 1945, all of which were attacked and sunk to the bottom of the sea. The sunken ships can only be seen in cenotaphs and museums. Still, Konishi has developed a marker-less AR system that reproduces them as full-scale 3-dimensional (3D) models and displays them on smartphone screens at their landing sites using Global Navigation Satellite System (GNSS) radio waves.

Therefore, we began to think about the project's content, which would provide visitors with an opportunity to reflect on the contributions of the scientific engineers and manufacturing craftsmen of the time and the history of support from residents while viewing the AR naval ship models along with the current landscape. We originally planned to take a bus to the AR viewing sites, but we found that the Kure Bay coastline has many steep slopes, and securing a place to park the bus was impossible. Later, with a grant for the promotion of tourism product development (cross-industry collaboration) in fiscal 2022, we completed a tour of the cruiser "Aoba," battleship "Hyuga," battleship "Ise," aircraft carrier "Katsuragi," and aircraft carrier "Amagi" as a Japan-originated tour to view the ships from aboard using AR. In March 2024, we started a trial with a major travel company for a sightseeing tour of the history of Kure and its surroundings.

When planning the event, we assumed that participants would be men and women in their 60s interested in history. Nevertheless, most participants were older, ranging from their late 60s to 80s, with the oldest in their 90s. About 30% of the first-time participants complained in the post-program questionnaire that they found the AR equipment difficult to use and could not see. Therefore, this study aimed to explore what improvements and support would satisfy the older participants.

Methods

Participants

They were men and women, mainly from the Tokyo metropolitan area and the Kinki region, who participated in a sightseeing tour to learn about the history of the former naval port offered by a major travel agency. The tours were conducted five times on the same schedule, on March 9, 16, 24, June 15, and August 24, 2024

(all on Saturday mornings). The number and ages of participants in each session were 53-80 (20, average 67.0), 41-76 (26, average 65.3), 24-90 (20, average 64.5), 66-79 (7, average 75.0), 53-79 (14, average 66.4).

AR Equipment

The AR application was operated with the smartphone LG Velvet L-52A (LG Electronics, released in December 2020, dimensions: approx. 167 x 74 x 7.9 mm, weight: approx. 180 g) and the AR glasses Nreal Air NR-7100RGL (Nreal, released in March 2022, resolution 1920 x 1080 pixels, weight approx. 79 g) as display device; the AR glasses were connected to the smartphone with the included Universal Serial Bus (USB) Type-C cable. We were concerned about battery deterioration since we had to use used equipment to keep the budget low. We prepared a spare mobile battery (ELECOM Co. Ltd., DE-C37-5000DGY, size 63 x 92.5 x 12.7 mm, weight 110 g) to deal with a dead battery on board. In addition, a small heat sink (Tuloka, material: aluminum, size: 70 mm × 22 mm × 6 mm, weight: 50 g) was glued to the back of the smartphone to prevent thermal runaway. Although the display on the AR glasses is better than a smartphone screen outdoors, we found that the environment is still very bright at sea in good weather, making it difficult to see the image. Therefore, authors Ishihara and Konishi designed a glass cover to reduce light entering around the wearer's eyes, fabricated it with a 3D printer (material: Acrylonitrile Butadiene Styrene (ABS) resin, weight: 136g), and attached a light-shielding filter. To get a better view of the AR warship, participants had to carry three pieces of equipment at once as they moved in and out of the ship's cabin and onto the deck. So, we created a carrying board to hold the smartphone and the phone's battery and to temporarily hold the AR glasses and cables so the participants wouldn't drop them.

Figure 1. AR equipment. (Material: wood board and ABS resin, size: 320 x 220 x 28 mm, weight: 292 g, with a neck strap. Later, we no longer used the carrying board.)

Itinerary

Participants had taken a tour the day before, visiting the former Naval Academy and other sites. They tasted a dinner featuring reproductions of old naval cuisine and listened to a lecture by one of the founding and operating members of the Yamato Museum, including a video recording of the air raid on Kure. At 7:45 a.m. on the second morning, participants and staff boarded a small passenger boat from a private pier in front of the Clayton Bay Hotel, where they stayed for the morning cruise. After the cruise, participants arrived at the Kure Central Pier, disembarked, and boarded a bus for the next stop, a lecture at the Historical Museum.

Cruise Course

Besides the captain, a guide from the shipping company, an attendant from a travel agency, and three to four AR equipment operation support staff ("AR staff") accompanied the cruise ship. Shortly after leaving the port, the ship visited the destroyers docked at the Maritime Self-Defense Force Headquarters and other ships and then sailed along the coast near the wreck sites of the Aoba, Hyuga, Ise, Katsuragi, and Amagi. The course of the ship is shown in *Figure 2*. The first of these, the "Aoba," had relatively good reception due to its proximity to downtown, so the ship stopped near the landing site, where AR staff explained how to use the AR equipment while using it. The guide then introduced the highlights of Kure Bay, including the Ondo Bridge, and as the ship approached the landing site, the staff told the participants to put on the AR equipment and observe the ship.

AR Observation Procedure

1. 1st to 3rd trial: We prepared a carrying board with a pre-charged smartphone and a spare battery attached, and the AR staff gave each participant the entire board with the smartphone and AR glasses turned on and connected by cable as they boarded the ship. Near the "Aoba" landing site, AR staff explained how to use the AR equipment and let the participants perform the procedure. Specific steps: (1) tap the smartphone screen to launch the AR application, (2) align the compass displayed on the application screen with the orientation of the smartphone so that the arrow points north, (3) once in the area near the ship's landing site, the name of the ship will appear on the smartphone screen. (4) Adjust the orientation of the AR glasses with your smartphone, (5) tap the "direction adjustment" button on the application, (6) put on the

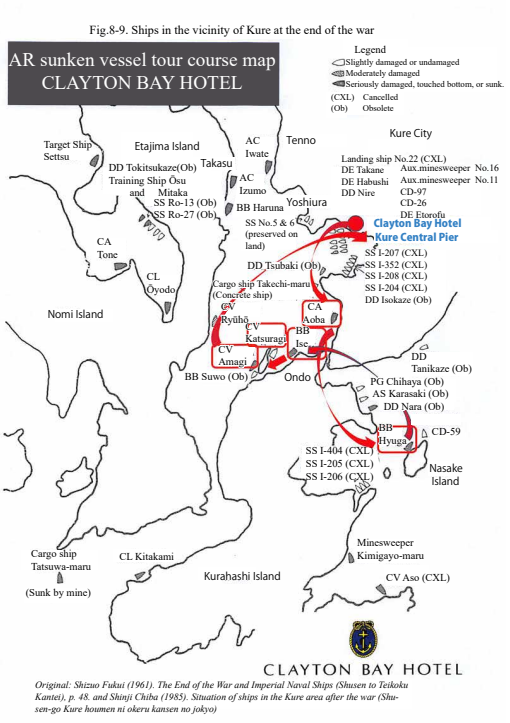

Figure 2. Cruise course. AC: Armored cruiser, AS: Submarine tender, BB: Battleship, CA: Heavy Cruiser, CD: Escort ship, DE: Destroyer escort, CL: Light cruiser, CV: Aircraft carrier, DD: Destroyer, PG: Patrol gunboat, SS: Submarine. (The author translated the original Japanese document for this article.)

AR glasses (or over them if you wear glasses), (7) raise their gaze to the height of the shore and face the direction of the arrow displayed on the AR glasses, and the computer graphics (CG) model of the naval vessel will be displayed. The 3D CG model of the Navy ship is made in actual size, and the distance and direction from which the participant views it is reflected in the display. After AR observation, (8) unplug the phone cable from the AR glasses and connect it to the spare battery to conserve phone battery power. When approaching the next ship landing site to observe, (9) disconnect the cable from the spare battery and reconnect it to the AR glasses. The same procedure was repeated at each subsequent ship landing site.

2. Fourth and 5th trials: only the AR glasses and phone were placed in a paper bag and given to the participants as they boarded the ship. Attendants did not use the spare battery and the carrying board. This change was because the average remaining battery charge on the phone in the previous three trials was close to 80%, so we decided that there was no need to charge the phone on the way to the ship. This change eliminated the procedure of reconnecting the cable after one marine observation and before the next.

AR staff explanation methods

Based on the first trial and the questionnaire responses, the explanation method was changed as follows.

For the first trial, we decided that a person familiar with AR equipment would be appropriate. Hence, the co-developer of the AR application explained the operation, and Information engineering students assisted the participants.

For the second session, we decided that a person familiar with verbal explanations would be suitable. Thus, the author, Kuramoto, a hotel staff member, explained the operation and two other staff members assisted. We tried to use fewer words in the explanation to give the participants the impression that it was easy.

The third time, with the same members, we tried to keep the operation explanation brief. Working with the ship company's onboard guide, we smoothly switched between the outside view and the AR explanation.

The fourth time, with the same members, we let them use only their smartphones and AR glasses to simplify the operation so we could further shorten the operation explanation.

In the fifth session, Keiko Ishihara, a university faculty member, briefly explained the mechanism of AR using a large poster before the operation. Kuramoto explained the operation method, and Ishihara and three sociology students assisted. By allowing the students to assist in the operation, Kuramoto, who was the overall leader, was able to have a little more freedom to instruct the captain to view the ship larger and closer through the AR glasses and to ask the ship's guide to explain the ship's specifications in detail. After the final AR viewing, Ishihara briefly explained the glass cover's development process and ingenuity.

AR tour satisfaction questionnaire survey

At the time of the tour's launch, the tour company's sales staff was somewhat skeptical about the effectiveness of AR and did not mention it in the brochure, even though the company's tour guide was positive about AR. Therefore, no one joined the tour because they were interested in AR. The tour guide explained the AR tour after the participants arrived on the first day, and everyone agreed to participate. The staff distributed the questionnaire after the participants boarded the ship

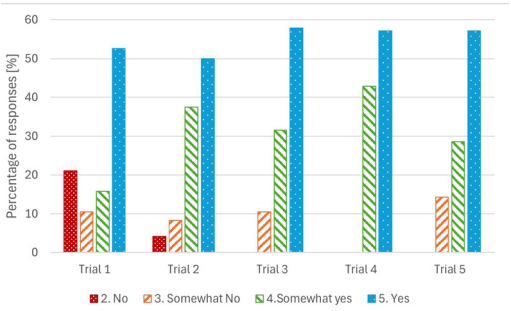

Figure 3. Ease of understanding how to use AR devices.

along with the AR equipment, and voluntary responses were requested. The questionnaire was collected with the AR equipment when the participants disembarked after the cruise, which took about 1.5 hours. Since this was a tour with public funding, the questionnaire had already been created when we started our research, and we only used the responses we received for our research.

The questionnaire consisted of five items printed on paper.

Q1. Did you understand how to use the AR glasses and equipment? (Choose one of 5 options: Yes, Somewhat Yes, Somewhat No, Don't Know)
Q2. How satisfied were you with the AR cruise experience? (Choose from 5 options: very satisfied, satisfied, normal, dissatisfied, very dissatisfied)
Q3. How would you rate the quality and content of the AR content provided? (Choose from 5 options: very good, good, normal, poor, very poor)
Q4. What is your preferred price if you would like to pay for the AR experience? (Describe the amount in yen)
Q5. What would you like to see improved in the AR travel experience? (Free description)

The questionnaire did not ask for respondents' profiles, such as name and age.

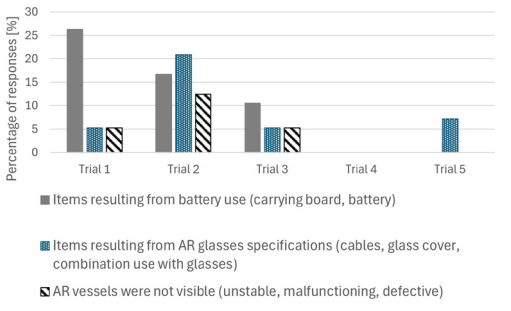

Figure 4. Classification of dissatisfaction with AR equipment in the free description.

Method of analysis of questionnaire responses

The frequency of responses to each question item was tabulated for each trial session. We performed The Brunner-Munzel test (Brunner and Munzel, 2000) as a test of the median of two groups with no correspondence, without assuming a distributional form after the frequency of responses was tabulated. We used the A (Vargha and Delaney, 2000) to estimate the effect size. This measure represents the probability that a randomly selected value from one group exceeds a randomly selected value from the other group. Open-ended responses were classified by content.

Results

The number of questionnaires collected and the response rates were 19 (82.6%), 24 (92.3%), 19 (95.0%), 7 (100.0%), and 14 (100.0%) for each session. Responses to the questionnaire were scored, with the most positive response being 5 and the most negative response being 1. Tabulation yielded the following results.

Ease of understanding how to use AR devices

As shown in *Figure 3*, "Yes" was answered by about half to 60% of the respondents, and if "Yes, to some extent" is included, the percentage improved from about 70% the first time to about 90% the second and subsequent times. "No" responses disappeared after the third time. The free-response comments about the equipment are categorized in *Figure 4*. Initially, respondents mentioned the poor usability of the carrying board they used to charge their phones frequently and something about the battery, but after the fourth time they stopped using it, there were no more descriptions; the comments about the specifications of the AR glasses (difficult to put on over the glasses, cables in the way) and about the AR glasses cover coming off remained. The comments about the AR glasses cover coming off remained. In addition, one to three participants in each session wrote in the free description that the operation was "difficult." Three responses across the five sessions indicated a desire for memory aid, such as "I would like a piece of paper describing how to use the system and how to recover from problems" and "I would like a map of the course at my fingertips. Regarding the audio, three responses indicated that "the engine noise makes it difficult to hear the voices."

Satisfaction with the AR-based cruising experience

Figure 5 shows the percentage of respondents who indicated that they were satisfied or very satisfied with the cruise experience, except for the second time, where approximately 80% of respondents indicated that they were satisfied or very satisfied.

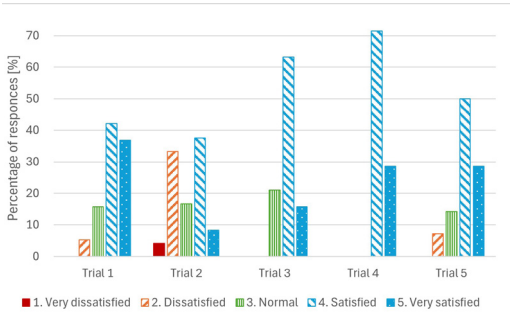

Figure 5. Satisfaction with AR-based cruise experience.

Quality and content of AR content

Figure 6 shows the results of the responses. 50-60% of the respondents answered "good" or "very good" except for the second time, and 10-15% responded "bad" or "very bad" except for the second and fourth time.

The main complaints about the quality of the AR images among the free descriptions were that the colors were "black and white," "not attached," or "not clear," "should be clearer," "no 3D effect", and "not realistic," with a total of 1 to 5 responses each for the five times. On the other hand, there were also positive responses such as "It was good to feel the size," "I want to stop and leave it at the place I like," and "It is good because I can imagine it sinking to the bottom of the sea." The means of the first 1-3 and second 4 or 5 responses were 3.31 and 3.75, respectively, and the medians were 3 (average) and 4 (good), with the second half being statistically significantly higher (W = 2.0884, df = 44.764, p = .04248, A = 0.0016).

Desired price assuming paid AR experience

Figure 7 shows the distribution of suggested prices for which responses were received. Blank and "?" were excluded from the analysis. Initially, some participants responded with 0 yen, but over time, some responded with progressively higher amounts.

Figure 6. Quality and content of AR content

Next, responses ranging from 1,500 yen to 2,000 yen were represented by a median value, such as 1,750 yen. When the histogram was smoothed to obtain a curve (Gu, 2014), as shown in *Figure 8*, the peak amount was the same for the first (1-3 times) and second (4 or 5 times), but the peak amount was 1,000 yen, indicating that responses for lower prices decreased and moved to higher prices. The average and median desired prices were 975.5 yen and 1,900 yen, respectively, and 1,000 yen and 1,300 yen, respectively, higher in the second half. Significant differences were found (W = 3.8446, df = 34.525, p = 0.0004956, A = 0.0030).

General comments on the free description

Some of the comments included "The project is interesting," "It's good to experience it even if the weather is bad," "I hope they make more ships," "It's suitable for both children and the elderly," "I hope they continue the research and make it useful for tourism," and "I support it." On the other hand, there were also comments such as "Can't you make it perfect?" and "It would be better to improve it more and not release it until it is perfect."

Discussion

A major travel agency offered the two-day, one-night tour to learn about the history of the Kure Military Port. It corresponded to the travel purpose of historical visits for older adults, as summarized by Ishihara et al. (2016).

During the preparation phase, our biggest concern was that the batteries in our used smartphones would run out of charge during the tour due to battery degradation. Therefore, to conserve power and recharge the batteries as much as possible, we tried to unplug the AR glasses cable after each naval ship observation and connect them to spare batteries to recharge them even briefly before moving on to the next naval ship. If there was a complaint about not being able to see the naval CG at the site, the staff went to the person's seat to provide operational assistance or replace it with spare equipment.

The staff had no experience of being unable to see the AR and the real reason why the participants complained of not being able to see it is unclear. When the staff used the equipment collected from the participants who said they could not see the AR on board, they could see it without any problem. Then, we deduced the causes as follows. (1) A slight timing discrepancy in the USB cable connection prevented the AR Glass from connecting. Unplugging and reconnecting the cable almost solved the problem. (2) Even though the AR glasses display the ship

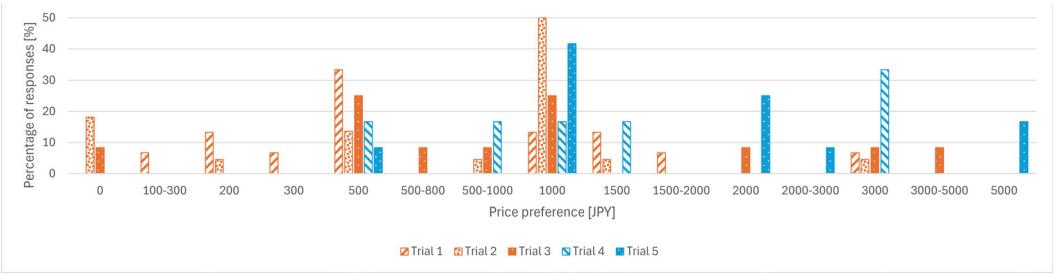

Figure 7(a). Distribution of responses for price preference when AR experience is paid for. (a) Distribution of price preference responses (Percentage of responses at each session).

correctly, the viewer did not notice it because their eyes were still looking down due to smartphone operation. Staff can solve this problem by talking to participants to make them aware. (3) The smartphone displayed the naval ship in the wrong orientation from the one set because the user needed to adjust the smartphone's and AR glasses' orientation, or the attempt to do so was unsuccessful. The comment "It's hard to turn around" indicates the physical inflexibility of older people. More than that, the comment "the ship appears in a different direction depending on the person" was another complaint, suggesting the importance of sharing the experience with peers. It is desirable to improve the procedure so that participants can adjust the orientation without special awareness.

The importance of the external environment, such as staff explanations and displays, can be considered as follows.

The responses to Q1 indicate that about half of the participants could understand how to use the AR equipment without assistance, regardless of the explanation method or equipment used. On the other hand, the number of "rather yes" responses, the next highest level of understanding, increased dramatically after the second session when the explanation and assistance staff changed. This result suggests that even if the elderly guests did not understand the system at first, they gradually became accustomed to it and understood it when the staff provided concise explanations and careful operational assistance. On the other hand, in the second trial, just after the staff change, 37.4% of respondents were "very dissatisfied" or "dissatisfied" with the Q2 cruise experience. The dissatisfaction at this time was mainly attributed to the fact that they could not see the AR display, suggesting that it is essential for the staff to become proficient in dealing with equipment problems. However, it was found that there were a small number of older adults who enjoyed the cruise but could not adapt to the AR experience.

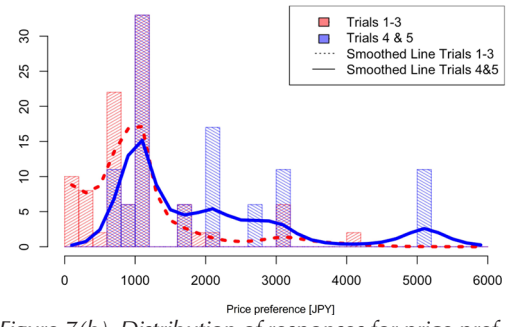

Figure 7(b). Distribution of responses for price preference when AR experience is paid for. (b) Histograms of price preference and smoothed curves.

Older people's visual and auditory functions influence the poor color and three-dimensionality of the displayed AR naval ship models, the lack of precision and realism, and the difficulty of hearing the explanatory voice due to the engine noise. The participants also mentioned the need for memory aids, such as a piece of paper with specifications, maps, and operating instructions for AR naval ships. On the other hand, many participants were impressed and satisfied by the size of the ship. Therefore, in the fifth session, the ship's path was moved closer to the AR model so that it was larger, and the viewpoint was from below, looking up. This change increased the number of participants impressed by the vessel's size but also in comments requesting a more advanced experience, such as "I can only see the boat from the same direction" and "I want to see the bow and stern more clearly." Improvements in this area would improve the content and quality rating. When university students and a faculty member were on board for the fifth time, there was an increase in comments expressing hope for future improvements in planning, such as a desire for further research, suggesting that the program helped to increase the sense of self-involvement among the elderly participants. Kuramoto explained the operation, and the tour operator's attendants commented that the atmosphere on board was younger and more relaxed. The cooperation of the younger participants can also help support the staff.

It is interesting to note that the value of this project (Q4), expressed in terms of monetary value, peaked at 1,000-2,000 yen even in the latter four or five times, with the highest value at 5,000 yen, which is similar to the experience of crowdfunding support by people in their 60s. In a survey conducted by Mitsubishi UFJ Research & Consulting Co., Ltd. (2020) of 25,510 men and women in their 20s and older, 104 respondents in their 60s who had supported a purchase-type or donation-type project out of 6,000 respondents in their 60s gave the following reasons for their support: sympathy with the dream and thoughts of the person who implemented the project (51. 0%) The most common reasons given by the 104 respondents in their 60s who supported a purchase-type or donation-type project were empathy with the dream and aspirations of the project sponsor (51.0%), followed by the ability to directly support the person, business, or region they wanted to support (42.3%), and the ability to contribute to society (27.9%). The strengthening of the statement in this project's fifth study may have had something to do with this.

The experience described in this paper exemplifies how the assistant overcame the difficulties caused by the simultaneous use of two devices, a dedicated smartphone, and AR glasses. The setting was at sea, and using AR glasses was effective for viewing large objects out of the field of view. On the other hand, AR historical sightseeing in Japan often points the camera of the participant's smartphone at a fixed position on land to recreate an old castle or as a virtual guide, in which case the difficulties described here do not occur. We believe that the findings presented in this study will be helpful when we get older adults access to slightly more complex devices with which they are unfamiliar to provide them with experiences with new value.

Limitations of this study include the fact that participants were limited to older Japanese from large metropolitan areas who had applied for guided tours offered by a major travel agency and thus had some wealth, time, and expectation of a guide and the small sample size of 83 participants.

Conclusions

We tried to improve the "AR Naval Vessel Tour," which was designed to introduce the unique history of Kure Bay as part of a travel agency tour. We described the results of our efforts to increase the satisfaction of older people who participated in the tour. The purpose of the tour was to allow participants to share the same view of former Imperial Navy ships sunk under the sea, which cannot be seen from land, by approaching the sunken point from the ship and viewing a reproduced CG by AR, and to try to encourage future learning among the participants. The participants were older than assumed in the planning stage, and we had to balance the need to reduce the battery drain on the equipment with the difficulty of operation related to the perceptual and cognitive functions of older people.

In conclusion, AR technology may be acceptable to many older people, but only about half of them can use it without assistance. In addition to the simplicity of the operating system, concise explanations by staff with extensive experience in dealing with older people, a good sound environment, friendly operating aids, and memory aids through printed materials are essential for the success of operation by the remaining participants. In addition, we found that to facilitate the understanding of the contents, showing the contents in more detail, explaining the AR technology in a way that makes it seem familiar, showing how we developed it, and showing the involvement of university students can also contribute to the sense of social participation and contribution to society by the elderly, thereby increasing their satisfaction and value.

In Japan, it has been reported that fulfilling leisure activities are important for older adults to increase their sense of purpose in life (Harada et al. 2011; Imai et al. 2012) and are also associated with the onset of dementia (Ling, et al. 2020). In the future, we would like to collaborate with university students and other young people to improve the content and create a sightseeing plan that allows participants of different generations to use AR as a gateway to learning about history.

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References

Japan Association for Financial Planners (2018). Comparison by generation - Survey on life and money in 2018. (Sedai-betsu hikaku, kurashi to okane ni kansuru chousa 2018) News release, (in Japa-

nese) https://www.atpress.ne.jp/releases/170259/att_170259_1.pdf

Yomogida, T. (2019). Data shows that the future of travel for older people in the "era of longevity (De-ta kara miru kore kara no koureisha no ryokou ni tsuite)," Column, Tourism Insight, JTB Tourism Research & Consulting Co. (in Japanese) https://www.tourism.jp/tourism-database/column/2019/02/longevity-senior-travel/

Japan Tourism Agency (2024). Travel and Tourism Consumption Survey 2023 Annual Tables (Fixed Report). (in Japanese) https://www.mlit.go.jp/kankocho/content/001740849.xlsx

Y-F. Ho, L-S. Lu (2014). Behavioral analysis of the active aging groups' ecotourism travel experience. Gerontechnology, 13(2), 204-204. https://doi.org/10.4017/gt.2014.13.02.335.00

Ishihara, S., Nagamachi, M., Kajioka, M., Aoki, S., Tsuchiya, T. (2016). Elder trip activity: A comparative research. Gerontechnology, 15(0), 126-126. https://doi.org/10.4017/gt.2016.15.s.773.00

Srifar, D. (2018). 360 virtual reality travel media for elderly. arXiv:1807.09074, https://doi.org/10.48550/arXiv.1807.09074

Yu, J., Kim, S. (Sam), Hailu, T. B., Park, J., Han, H. (2023). The effects of virtual reality (VR) and augmented reality (AR) on senior tourists' experiential quality, perceived advantages, perceived enjoyment, and reuse intention. Current Issues in Tourism, 27(3), 464–478. https://doi.org/10.1080/13683500.2023.2165483

Mitsubishi UFJ Research and Consulting (2020). Crowdfunding (purchase-type) Trend Organizing (Kurau-do fanding (kounyuu-gata) no doukou seiri) (in Japanese). https://www.caa.go.jp/policies/policy/consumer_policy/caution/internet/assets/caution_internet_201013_0001.pdf

Gu, C. (2014). Smoothing Spline ANOVA Models: R Package gss. Journal of Statistical Software, 58(5), 1–25. https://doi.org/10.18637/jss.v058.i05

Brunner, E. and Munzel, U. (2000). The nonparametric Behrens-Fisher problem: Asymptotic theory and a small-sample approximation. Biometrical Journal, 42, 17-25.

Vargha, A. and Delaney., H. D. (2000). A critique and improvement of the CL common language effect size statistics of McGraw and Wong. Journal of Educational and Behavioral Statistics, 25(2), 101-132.

Harada, T., Kato, K., Oda, Y., Uchida, H., Ohno, T. (2011). Daily Habits of the Elderly (II): Recreational activities and feeling of life. Journal of Nagoya Bunri University, 11, 27-33 (in Japanese).

Imai, T., Nagata, H., Nishimura, Y. (2012). The reliability and validity of a new scale for measuring the concept of Ikigai (Ikigai-9), Japanese Journal of Public Health, 59(7), 433-439 (in Japanese).

Ling, L., Tsuji, T., Nagamine, Y., Miyaguni, Y., Kondo, K. (2020). Types and number of hobbies and incidence of dementia among older adults: A six-year longitudinal study from the Japan Gerontorogical Evaluation Study (JAGES). Japanese Journal of Public Health, 67(11), 800-810 (in Japanese).