ICCEPM 2022
The 9th International Conference on Construction Engineering and Project Management
Jun. 20-23, 2022, Las Vegas, NV, USA

Enhancing the digitization of cultural heritage: State-of-Practice

Thu Anh Nguyen [1,2], Anh Hoang Trinh [1,2], Truong-An Pham[1,2,*]

[1] *Faculty of Civil Engineering, Ho Chi Minh City University of Technology (HCMUT), 268 Ly Thuong Kiet Street, District 10, Ho Chi Minh City, Vietnam*
[2] *Vietnam National University Ho Chi Minh City, Linh Trung Ward, Thu Duc District, Ho Chi Minh City, Vietnam, E-mail address: *tran.pham@hcmut.edu.vn*

Abstract: The use of Hi-Tech in cultural heritage preservation and the promotion of cultural heritage values in general, particularly artifacts, opens new opportunities for attracting tourists while also posing a challenge due to the need to reward high-quality excursions to visitors historical and cultural values. Building Information Modeling (BIM) and Hi-Tech in new building management have been widely adopted in the construction industry; however, Historic Building Information Modeling (HBIM) is an exciting challenge in 3D modeling and building management. For those reasons, the Scan-to-HBIM approach involves generating an HBIM model for existing buildings from the point cloud data collected by Terrestrial 3D Laser Scanner integrated with Virtual Reality (VR), Augmented Reality (AR), contributes to spatial historic sites simulation for virtual experiences. Therefore, this study aims to (1) generate the application of Virtual Reality, Augmented Reality to Historic Building Information Modeling - based workflows in a case study which is a monument in the city; (2) evaluate the application of these technologies to improve awareness of visitors related to the promotion of historical values by surveying the experience before and after using this application. The findings shed light on the barriers that prevent users from utilizing technologies and problem-solving solutions. According to the survey results, after experiencing virtual tours through applications and video explanations, participant's perception of the case study improved. When combined with emerging Hi-Tech and immersive interactive games, the Historic Building Information Modeling helps increase information transmission to improve visitor awareness and promote heritage values.

Keywords: HBIM, Historical Heritage, Temple of Hung Kings, VR/AR, Virtual Tours.

1. INTRODUCTION

Traditionally, facility delivery has relied on 2D drawings; this approach results in documented inefficiencies as errors and paper omissions [1], causing field delays and lawsuits. Regardless of the contractual approach taken, managing an effort involving several parties and documents is difficult, then Building Information Modeling (BIM) has been promoted to shape the construction sector into a practical, environmentally sustainable, and globally competitive [2]. The application of informative digital modeling to the historic building is a relatively new area of study, leading to a well-structured and rich 3D digital model [3, 4], resulting in a growing body of research for new buildings and existing buildings such as Cultural Heritage (CH). Scan-to-BIM projects have been applied 3D Laser Scanning (LS), upgraded with Hi-Tech (VR, AR) to digitize and promote CH values, offering an enormous opportunity for digital tourism [5]. Previous research has shown that

the as-built BIM approaches include context-based [6], heuristic [7], ontology-based [8], and prior knowledge-based approaches [9], while the current requirements for survey rectify photography, photogrammetric, orthophoto-graphic, architectural, and topographic techniques [10].

Furthermore, the role of the Metaverse as a mediator between technological trends and societal and business applications; is defined as a globally accessible 3D virtual space and computing infrastructure and still a conceptual vision [11]. The emerging technology supports the interacting experience of visitors by allowing interaction with the virtual world in real life through the quality of virtual multi-dimensional spatial models on electronic devices in a metaverse environment. Then visitors may immerse themselves in heritage virtual tourism, which brings about economical [5, 12], spiritual and cultural values [10] to the community. In the late 1960s, the first known attempt to improve human vision using digital information appeared [13]; using a fully immersive VR tour can manage complex CH yards for academics and the general public [14]. Most CH sites are devoid of helpful information or user guides, showcasing all the site's rich heritage to visitors, which detracts from the overall experience and brings about the disinterested and unmotivated using traditional mediums felling of visitors to CH sites [15, 16].

The mentioned technologies will be used in a case study of a monument in the city to generate and evaluate the application of these technologies to improve visitors' awareness of the promotion of historical values by surveying the before-after Apps experiences. The results shed light on the obstacles that users face when attempting to use new technologies and creative approaches to solving problems. This study does not go into technical details but rather develops a broader model of heritage digitization. The analysis and integration of BIM, VR, and AR to enhance historical site experiences are focused; scan or scan-to-BIM technical issues will not be discussed in depth. By conducting a practical Hi-Tech integration in HBIM workflow, the study aims to orient the future research on tourism promotion under metaverse applications (Mobile VR AR application, PC game, YouTube, and Facebook simulation video). The integration of Hi-Tech in the HBIM aims to promote the public consciousness about the intangible values of CH, disseminating good historical information that needs to be preserved. Two surveys are examined in this study to investigate the effectiveness of technology integration on public awareness.

The Temple of Hung Kings, a tangible CH in Vietnam, located in District 1 of Ho Chi Minh City, is chosen for the practical case study. The priority in selecting the best-case study is the appropriate location for data collection and a small-average scale of quickly forgotten heritage. Recently, this 100-year-old Relic was designated a historic site in 2015, given a conservation priority rating [17, 18]. However, the tourism promotion at the Temple of Hung Kings is limited and is falling into oblivion. This study uses the Trimble Platform for point cloud data processing[1] , while Autodesk software for BIM processing other tools for model development are mentioned in the results section. In this study, Trimble X7 is suitable for point cloud acquisition as the area of Hung King Temple is around 400-600m^2 while the range of Trimble X7 is 0.6-80m. This scanner allowed the user to verify that the point cloud met registration requirements and that auto-orientation was completed prior to scanning by providing a complete in-field registration.

2. LITERATURE REVIEW

[1] DAT HOP COMPANY LIMITED (No. 2, Street 4., Van Phuc Riverside, Hiep Binh Phuoc Ward, Thu Duc City, Ho Chi Minh City, Vietnam); partly supports for equipment and software besides the financial support from AUN/SEED-net.

The applications of emerging technologies in the CH can be seen from drawings to parametric modeling transition, parallel with the transition from restoration as an event to conservation as a process. The status of the site can be transferred to digital modules using LS, which can then be processed to create spatial objects and be reserved for the BIM for the later O&M phase [19]. The BHIMM (Built Heritage Information Modeling Management) project was started in 2011 and is still going strong today with the shift from restoration to preventive conservation, increased interest in management knowledge, and databases development [20, 21]. The BHIMM project results prompted a revised approach and further research into more effective technological transfer of BIM potentialities to historic buildings [21]. Overall, the Scan-to-HBIM workflow includes three main steps includes data acquisition, data interpretation, and application, in which fundamental problems emerge when dealing with the step from point-clouds to parametric models for architectural conservation, the Level of Development (LOD) of the project should be clarified from the beginning [19, 22, 23]. Ensuring that the historical complexity is incorporated from the beginning of the project will help to ensure that the construction site is not interrupted by unexpected and costly costs and that heritage monitoring is used as a strategy for planned conservation over time [22].

To this end, the researchers found that raising visitor awareness of a tourist destination's value helped preserve its CH. It is reasonable to use modern technology to widespread tangible and intangible values since there is a relationship between technology, CH, and technology users [24, 25]. Youngs and digital savvy have a high peak consumer demand for tourism, always ready to experience, follow current trends, and enjoy variety, which explains their high and diverse demand for tourism [24]. They are a group of eager new explorers, and new tourist attractions allow them to see more of the world. Most young stated that they are most interested in content related to travel and their personal experiences. Academics have studied the AR conceptualization, characteristics, and framework, including research on immersing tourists in a virtual world using only a smartphone and a VR head [26, 27]. AR, VR, Mobile AR for CH, and 360-degree images in tourism development promote heritage images to the community, bringing individuals closer to exchanging information through CH and sharing cultural worth [5, 28]. According to the evidence presented here, incorporating LS and BIM with Hi-Tech is undeniably advantageous. Previous research has concentrated on the technological value of these great uses rather than improving CH, sharing heritage information, or practical workflows in a specific heritage case study, then evaluating the application of these technologies to improve visitor awareness related to the promotion of historical values by surveying the experience before and after using this application. For these reasons, conducting this study is critical.

3. Research Methodology

The workflow (see Fig 1) below depicts five steps for enhancing cultural heritage digitization in this study. Based on the purpose of the project case study, the appropriate LOD is conducted for the HBIM, and then the researchers obtained the appropriate point cloud data density using the Trimble X7 laser Scanner by controlling the distance and position between scanning stations. The first survey form also is designed from the beginning of the study. This survey is used to assess the understanding of the local people's case study for usefulness evaluation and collect opinions on the experiencers' expectations to build product Hung King Hub Applications (HKH Apps) later. After the scanning process with 3D Laser Scanner, the parameters for the HBIM are defined by the BIM manager. Based on the point cloud model and the defined parameters, the HBIM is conducted. The HBIM-based workflow is summarized parallel to Hi-Tech's integration in HKH HBIM. Immediately after completing HKH HBIM, the questionnaire forms will be posted to the media to

begin the first data collection. These pre-experience surveys will assess visitors' background information about the Hung King's Temple.

The integration of Hi-Tech components into HKH HBIM can be used for educational, training, and awareness-raising purposes. Developing HKH Apps is to encourage people to engage with the digital CH and in-hand Apps. A survey form is sent to a wide range of citizens, asking them to rate the ease with which these technological products can be understood, manipulated, enjoyed, and found helpful. This case study focuses on three HKH Apps: Augmented Reality for Mobile Devices (HKH MAR), Desktop Virtual Adventure (HKH VAD), and Three-dimensional visualization (HKH V3D) (see Fig 2). The researchers solicited data about research projects via relevant (behavioral) variables. Because the questions are multiple-choice, respondents only need to check the answers they believe are most relevant. For this purpose, the researchers asked participants to answer multiple-choice questions related to the Temple of Hung King and the historical meaning of King Hung. Those who agreed to participate received a letter outlining the study's objectives and instructions on using Hi-Tech. Each participant's time spent interacting with the App was evaluated following the study.

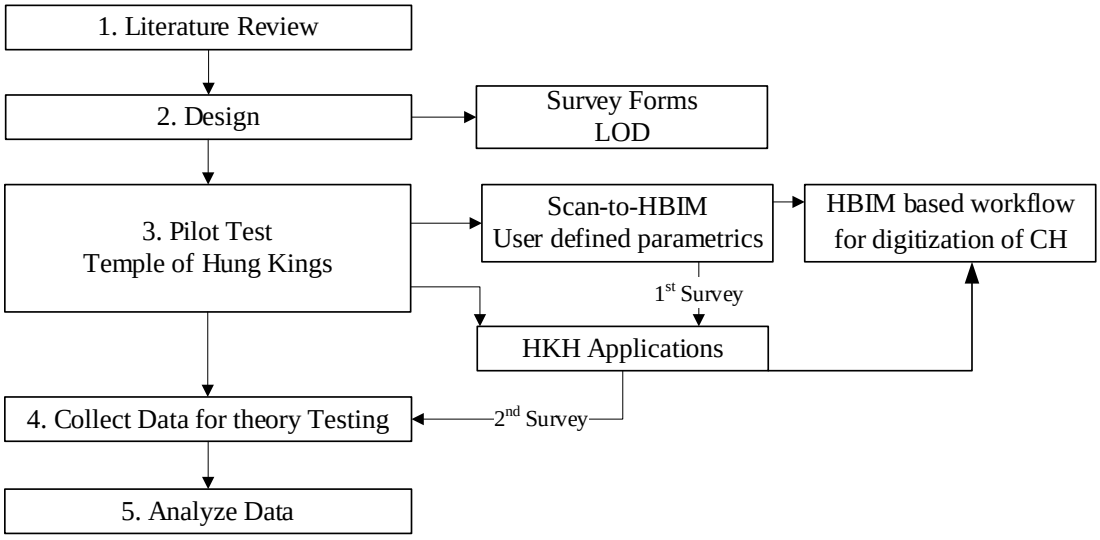


Figure 4. Research Methodology

When the product is published publicly, the second survey is conducted for the same purpose as the first survey. From that researcher evaluate and compare the given response to appraise if the application of high technology in the heritage has provided any valuable information to society. The HKH Apps are developed for creating immersive and interactive BIM environments with real-time rendering, using VR and AR games. The survey participants have been provided the YouTube, Facebook, and Google Drive links for Apps download and guidance. A video demonstration is also provided for those unfamiliar with technology. The study employed a non-probability sampling technique; subjects included those interested in tourism, digitizing works, and residing in Ho Chi Minh City. During the first ten days of July 2021, a questionnaire was sent out over the Internet to gather data for the evaluation. The questionnaire was delivered due to the Covid-19 pandemic and the inability to contact individuals.

4. RESULTS

4.1. HBIM based workflow for digitization of cultural heritage

The Point Cloud Model (HKH PCM) is the first product created following the scanning process in CH digitizing. HKH PCM is the critical product for quality control, which decides the products chain of HKH Apps. In this phase of data processing, the HKH PCM represents the comprehensive 3D model in terms of the geometry of the Temple with authentic materials texture and as-builts dimensions. The collected historical facts and O&M info will then be merged into the HKH HBIM after the Scan-to-BIM process, thanks to Software support as-built and programming tools. Libraries for architectural elements and materials are a significant issue in Scan-to-HBIM projects. Due to the lack of available information libraries in ancient structures, the BIM library definition is the only way to ensure product quality. When developing a BIM library, the goal of utilizing information modeling throughout the project's lifecycle must be adhered to. In this case study, the LOD 400 is set up initially. The HKH PCM and HKH HBIM can be immediately used for the analysis and evaluation degree of damage, the operation and maintenance of facility management, parties sharing, communication, and collaboration.

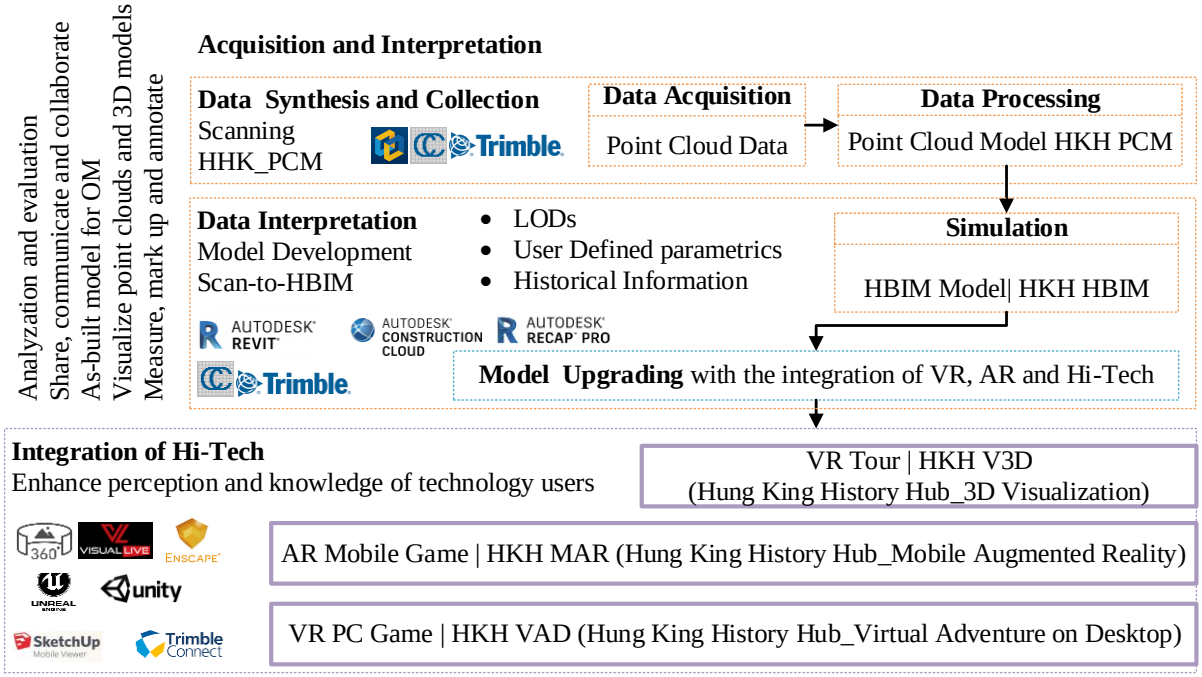


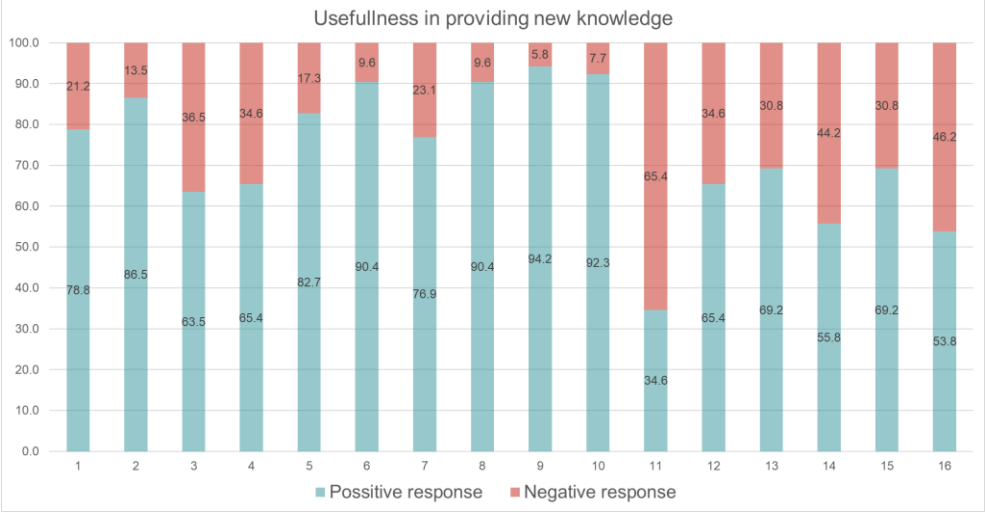
Figure 5. HKH – Integration of Hi-Tech in Hung Kings History Hub

HKH Apps allows the player to explore the virtual Temple on personal computing devices. While HKH V3D refers to the program that connects the user to Enscape's VR experience within a click on a web browser, allowing architectural screen visiting and historical information accessing; the HKH MAR was developed to monitor the three-dimensional image of the Hung King's Temple via a handheld Android mobile device by a device tracking application built on the Unity platform. In HKH MAR, the Vuforia Sensor Combination Technology Application is activated and moved over the 2D image of Hung King Temple to detect the augmented virtual interactive 3D model. As a result, the user can filter the 3D objects selected, such as textures, decorative sculptures, and furniture objects, and carefully read the description attached to each object. The third App, HKH VAD, is intended to educate the public and young people about the relics of Hung King Temple. It is designed to bring about the role-playing game for users on any desktop display, allowing running, walking, and touching activities.

4.2. Validation and evaluation

The online survey form is distributed to citizens to assess these technological products' usefulness, comprehensibility, manipulability, and enjoyment. The utility (1) of HKH Apps is accessed by comparing the answers from two surveys to evaluate the correct answers to questions about monuments before and after experiencing HKH Apps. The first part of the survey gathers comprehensive demographic data on Hung King Temple, including architectural information (Q1-Q5, Q16), intangible value (Q15, Q13, Q9, Q6), and historical meaning (Q7, Q8, Q10, Q12, Q14, Q16) of the heritage (Fig 3). In other words, visitor knowledge of the Hung King Temple is assessed through pre-experience surveys, one prior to the following Hi-Tech experience. During the second stage of surveying, applications are developed in this section. Participants share their thoughts on the Hi-Tech integration in their Apps experiences in the final section. The final step is to determine whether the object can be manipulated, understood, and enjoyed. In addition, a small blank form should be provided for gathering the participant's data.

Two hundred sixty-five questionnaires were sent out to both sexes, with 252 of those responses being valid, with 74.2 percent of those surveyed being students and 25.8 percent being working adults. Among those who responded to the open-ended questions, 39.3% said they had heard of the Ho Chi Minh City relic of the Hung King Temple, while 33.3% had never heard of it, and the remaining one-third said they were very familiar with the Temple. The survey finds that 72.6 percent of respondents are unaware of its existence, so the case is well-known, but it is also a bit of a mystery that this Temple should be promoted because it has tangible and intangible benefits.



Question: In your opinion

1. The following images are typical of the architecture of the period?
2. What is the name of the item in the picture below?
3. The mentioned item is used for
4. What materials are the yellow details below made from?
5. In what form are the above details made?
6. What ceremony is the image below illustrating?
7. The pictures below depict the altars. Who is this altar to worship?
8. The image below is an image of a Temple. Which Temple is this picture?
9. How many generations of Hung Kings reigned?
10. The land first chosen by Hung Kings to be the capital is in our country today.
11. How many places in HCM city worship Hung Kings?
12. The image below is the Temple of Hung Kings. When was the Temple built?
13. In 2008, What is the Ancestral Anniversary festival of the Hung Kings was known to the whole world when UNESCO recognized it as the "Hung King Worshiping Ritual"?
14. Is the Temple of Hung King's first purpose of construction to commemorate Hung Kings?
15. What does the "12 Mahogany Black Columns" mean?
16. What is the name of this roof and tile system?"

Figure 6. Change in answers of participants in the survey related to the Temple of Hung King and Hung Kings History_ The usefulness of HKH Apps evaluation

The increase in the number of correct answers after using HKH Apps and watching product videos demonstrates the Apps' potential for imparting knowledge and attracting interest. The

evaluation finding from the survey data shows that participants' perceptions have improved. Most of the finding was accounted for by the conversion rate from False to True, implying that participants' knowledge of the Hung King Temple and the history of Hung Kings has improved, as evidenced by the change from False to True answers and the maintenance of True-True after the HKH Apps experience (positive results) (Fig 3). The negative results represent the unchanged wrong answers False-False and the step back from True to False answers. In general, the positive results notion outweighed the negative. Almost all questions have more than half positive results. The exceptions are when it comes to questions 11 (65.4 % negative results), 16 (46.2% negative results), and 14 (44.2 % negative results). The explanation for the high rate of false answers to questions is that those questions require in-depth knowledge, and in fact, in the HKH Apps development database, the authors did not add the information for those aspects.

Table 1 shows the question and means value collected from the second survey; participants can personally evaluate the HKH App on a 1-5 Linkert scale in the second survey. The four constructs of the questionnaire were used to assess manipulability (E1-4), comprehension (E5-9), enjoyment (E10-12), and overall assessment (E13-17). The survey assessment scale included items with both positive and negative wording. The study first reversed the results to have the same scale for the questions with negative formulations. As a result, the user may be more cautious when filling out the survey, and the response may be more relevant to the survey. The value of each criterion – Manipulation (mean = 4.30; SD =0.7), Comprehension (mean= 3.77, SD=0.88) and Enjoyment (3.93, SD=0.84), Overall assessment (mean=4.00, SD=0.76). At the end of the experiment, some participants showed interest in learning more about AR and how it could change the way people explore and learn new things about heritage and education.

Table 3. HKH Apps evaluation on manipulation, enjoyment, and comprehension

Criteria	Mean	Std. Dev.
Manipulation	4.30	0.699
E2. HKH Apps has helped me improve my understanding of culture and history.	4.37	0.627
E3. HKH Apps gave me quick access to the Temple image.	4.37	0.687
E1. HKH Apps made it simple for me to learn more about the Temple.	4.25	0.682
E4. HKH Apps will be beneficial when visiting the Temple's interior.	4.21	0.800
Comprehension	3.77	0.875
E6. I find it simple to interact with HKH Apps	4.04	0.816
E5. HKH Apps contains a lot of information.	3.94	0.802
E7. The information on the screen is simple to understand.	3.90	0.799
E9. The amount of information on the screen is just right.	3.69	0.805
E8. The information on the screen is easy to read.	3.27	1.157
Enjoyment	3.93	0.842
E12. I found this experience enjoyable.	4.33	0.678
E11. I found this experience very beneficial.	4.25	0.622
E10. Interacting with the experience makes me feel comfortable.	3.21	1.226
Overall assessment	4.00	0.757
E17. Overall assessment of the HKH Apps' experience.	4.10	0.634
E13. Overall assessment of the HKH Apps' image quality	4.02	0.671
E15. Overall assessment of the HKH Apps provided information	4.02	0.804
E14. Overall assessment of the HKH materials texture quality	3.98	0.852
E16. Overall assessment of the HKH Apps' LOD	3.90	0.823

The poll of questions is designed to assess the HKH's manipulability, giving the participants a chance to demonstrate how the 3D modeling experience brings about more accessible info. The highest value at 4.37 for E2 and E3 is proof of developing high-value HKH apps to spread knowledge and enhance heritage value. The questionnaires E5-E9 assess how well and how long people remember and understand information about the Monument. The low average score of Item E8 could be attributed to the information's lack of proper proportions for its overall interface. This, however, makes no difference to the message because HKH Apps is simple to use, detailed, and understandable for most users.

In the assessment of whether participants feel enjoyable after the Apps experience, the results show that this experience is fascinating, according to the E12, which had the highest mean value of 4.33. The responses of participants to Questionnaire E10 indicate that they felt at ease discussing their feelings about the interaction. This result is entirely appropriate in a novel and possibly unfamiliar application. This, however, did not appear to have any effect on how much fun the participants were having. When asked how they felt about the study's content and images, survey participants said they were "delighted" with 3D models and virtual reality applications (E17-4.10). When users are asked about the color quality and detail of the information, they are pleased with the results (E14-3.98; E16-3.90). This finding has no bearing on the study's goal of communicating user satisfaction with monument images and content.

5. CONCLUSION

This study developed precision and consistency from raw data processing to the finished point cloud model. It serves as the foundation for subsequent software development and project implementation phases. Collecting data on-site is the first step in developing an HBIM model. This phase will be accompanied by manuscripts, architectural designs, reports, and historical records. Changes in database formats and parameter options alter the shapes of existing elements, allowing for software processing error differences. Finally, data integration makes it possible to work with non-geometric data. The workflow has been carried out as the foundation of proposals to innovate the practices in the preservation field. The survey research has contributed to the future of Hi-Tech emerging in CH digitalization to promote tangible and intangible value. The scan-to-HBIM process is used in this study, and an HBIM model based on contemporary technologies is developed, applying for both O&M purposes and tourism boosting, which is something that previous studies have not done.

It is undeniable that the digital-savvy generation has rapid access to technology and the outstanding development of Hi-Tech; besides the outstanding advantages of applying them to historical buildings, the potential of promoting the value of CH can be seen. By surveying the experience before and after using HKH Apps, the study contributes to evaluating the application of these technologies to improve visitor awareness related to the promotion of historical values. The findings shed light on the obstacles that keep users from utilizing technologies and genuine concern solutions. The study results show the potential of using technology, digitizing heritage, and enhancing CH attraction tourism in the Metaverse era. The survey participants indicated curiosity in learning about AR and how it might affect people's approach to exploring and learning about heritage and education. These new paradigms influence all parts of our lives, whether a smartphone application, an online catalog or a social media interaction. They transform how we communicate, learn, and approach our environment. With technology that can link computer-generated digital information with the physical world, CH may benefit from this advancement by illuminating cultural remnants. Immersive tours help people learn more about a monument. The finding shows that promoting a tourist destination's value by increasing visitors' awareness of its

CH was beneficial. Consequently, integrating those technologies into the heritage brings about the new future of the digital twin in the city.

ACKNOWLEDGMENTS

This research is funded by Japan International Cooperation Agency Project for ASEAN University Network / Southeast Asia Engineering Education Development Network (JICA Project for AUN/SEED-Net) in the framework of Collaborative Education Program (CEP) under Program Contract No. HCMUT CEP 2101.

REFERENCES

[1] A. Sawhney, M. Riley, and J. Irizarry, *Construction 4.0: An innovation platform for the built environment*. Routledge, Taylor & Francis Group, 2020.

[2] S. E. N. Lau, R. Zakaria, E. Aminudin, C. C. Saar, A. Yusof, and C. M. F. H. C. Wahid, "A review of application building information modeling (BIM) during pre-construction stage: retrospective and future directions," in *IOP Conference Series: Earth and Environmental Science*, 2018, vol. 143, no. 1: IOP Publishing, p. 012050.

[3] N. Hichri, C. Stefani, L. De Luca, and P. Veron, "Review of the "as-buit BIM" approaches," 2013: Proceedings of the 3D-ARCH International Conference.

[4] A. Capolupo, "Accuracy Assessment of Cultural Heritage Models Extracting 3D Point Cloud Geometric Features with RPAS SfM-MVS and TLS Techniques," *Drones*, vol. 5, no. 4, p. 145, 2021.

[5] T. Jung and D.-I. Han, "Augmented Reality (AR) in Urban Heritage Tourism," *e-Review of Tourism Research*, vol. 5, 2014.

[6] X. Xiong and D. Huber, "Using Context to Create Semantic 3D Models of Indoor Environments," in *BMVC*, 2010, vol. 629, p. 635.

[7] S. Pu and G. Vosselman, "Extracting windows from terrestrial laser scanning," *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.*, vol. 36, pp. 12-14, 2007.

[8] H. B. Hmida, C. Cruz, F. Boochs, and C. Nicolle, "From Unstructured 3D Point Clouds to Structured Knowledge-A Semantics Approach," *Semantics-Advances In Theories and Mathematical Models*, vol. 213, 2012.

[9] K. Yue, D. Huber, B. Akinci, and R. Krishnamurti, "The ASDMCon project: The challenge of detecting defects on construction sites," in *Third International Symposium on 3D Data Processing, Visualization, and Transmission (3DPVT'06)*, 2006: IEEE, pp. 1048-1055.

[10] E. Heritage and E. D.-S.-M. B. Montagu, *English Heritage*. Macdonald [for] English Heritage, 1987.

[11] S.-V. Rehm, L. Goel, and M. Crespi, "The metaverse as mediator between technology, trends, and the digital transformation of society and business," *Journal For Virtual Worlds Research*, vol. 8, no. 2, 2015.

[12] D.-I. Han, T. Jung, and A. Gibson, "Dublin AR: implementing augmented reality in tourism," in *Information and communication technologies in tourism 2014*: Springer, 2013, pp. 511-523.

[13] D. Van Krevelen and R. Poelman, "A survey of augmented reality technologies, applications and limitations," *International journal of virtual reality*, vol. 9, no. 2, pp. 1-20, 2010.

[14] F. Fassi, A. Mandelli, S. Teruggi, F. Rechichi, F. Fiorillo, and C. Achille, "VR for Cultural Heritage," Cham, 2016: Springer International Publishing, in Augmented Reality, Virtual Reality, and Computer Graphics, pp. 139-157.

[15] V. Geroimenko, *Augmented Reality in Tourism, Museums and Heritage: A New Technology to Inform and Entertain*. Springer Nature, 2021.

[16] X. Lia, W. Yib, H.-L. Chia, X. Wang, and A. P.C, "A critical review of virtual and augmented reality (VR/AR) applications in construction safety," *Autom. Constr*, vol. 86 pp. 150–162, 2018.

[17] T. Son. "Hung Vuong Temple in Zoo and Botanical Garden is classified as a relic." https://vnexpress.net/den-hung-vuong-o-thao-cam-vien-duoc-xep-hang-di-tich-3241090.html (accessed.

[18] T. Doling. "Old Saigon Building of the Week – Hung King Temple, 1929." http://www.historicvietnam.com/hung-king-temple/ (accessed 2021).

[19] T. Nguyen, P. T. Nguyen, and S. Do, "Application of BIM and 3D Laser Scanning for Quantity Management in Construction Projects," *Advances in Civil Engineering*, vol. 2020, pp. 01-10, 12/28 2020, doi: 10.1155/2020/8839923.

[20] S. Della Torre, "Un bilancio del progetto BHIMM," in *Modellazione e gestione delle informazioni per il patrimonio edilizio esistente*, 2017: Ingenio, pp. 10-16.

[21] S. Della Torre and A. Pili, "Built heritage information modelling/management. Research perspectives," in *Digital Transformation of the Design, Construction and Management Processes of the Built Environment*: Springer, Cham, 2020, pp. 231-241.

[22] B. Daniotti, M. Gianinetto, and S. Della Torre, *Digital transformation of the design, construction and management processes of the built environment*. Springer Nature, 2020.

[23] T. Nguyen, S. Do, A. Pham, and C. Nguyen, *Application of BIM and 3D laser scanning for quantity surveying and quality management in construction projects*. 2021, p. 030003.

[24] T. T. N. Phạm, "Khảo sát nhận thức của giới trẻ về nguyên tắc ứng xử du lịch có trách nhiệm tại điểm đến," *Tạp chí Phát triển Khoa học và Công nghệ –Khoa học Xã hội và Nhân văn,* vol. 3, 2, pp. 63-71, 2019. [Online]. Available: http://huc.dspace.vn/handle/DHVH/4447.

[25] R. G. Boboc, M. Duguleană, G.-D. Voinea, C.-C. Postelnicu, D.-M. Popovici, and M. Carrozzino, "Mobile augmented reality for cultural heritage: Following the footsteps of Ovid among different locations in Europe," *Sustainability*, vol. 11, no. 4, p. 1167, 2019.

[26] D. L. Kerstetter, J. J. Confer, and A. R. Graefe, "An exploration of the specialization concept within the context of heritage tourism," *J. Travel Res*, vol. 39, no. 3, pp. 267-274, 2001.

[27] Z. Yovcheva, D. Buhalis, and C. Gatzidis, "Engineering augmented tourism experiences," in *Information and communication technologies in tourism 2013*: Springer, 2013, pp. 24-35.

[28] N. Chung, H. Han, and Y. Joun, "Tourists' intention to visit a destination: The role of augmented reality (AR) application for a heritage site," *Computers in Human Behavior*, vol. 50, pp. 588-599, 2015.