

Constructing Smart Digital Media for Museum Education Post Pandemic Recovery: A Review and Recommendation

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Abstract— The research conducted a literature review to find the trend of smart digital museum construction for education media that have been developed by utilizing information and communication technology and intelligent systems. A series of procedures and methods applied in the literature review process extracting information from dataset contained articles and journals in the 2015-2021 period. A physical or traditional museum must be transformed into a smart digital museum that can carry out an educational role even during the COVID-19 pandemic. The pandemic has made limitations to museum visits that impacted fewer activities and community visits for education in the museum. Museum performance for education is not optimal during a pandemic, especially in Palembang. The results of this study indicate a trend of digital smart transformation from physical or traditional museums. Applications based on mobile devices and websites are mostly developed 72.72% of applications for education in museums. Modern museums have begun to transform into digital museums implementing intelligent machine learning based systems in the last three years and with learning application content in the form of games, augmented reality or virtual reality, and information retrieval systems. The results of the study are expected to provide information for museum education post-pandemic recovery strategic planning in Indonesia.

Keywords— Smart museum education, software engineering, machine learning, recommendation, COVID-19

I. INTRODUCTION

The museum is a non-profit institution that has the role of education and recreation. The museum functions to protect, develop, and utilize museum collections and communicate them with the public so that their existence is maintained for the next generations. The museum keeps a collection of art, culture, or historical objects from the past that may no longer exist or be used today. In museum visitors can learn about collections and how they were in the past for educational or recreational purposes. Collection exhibition affects visit satisfaction. Collections are the main strength of the museum to attract public visits as well as other internal and external factors.

Internal factors that influence museum visits come from visitors themselves, including increasing knowledge, recreation, recovery, or entertainment, carrying out school assignments, and fulfilling curiosity about the museum and its collections [1]. Meanwhile, external factors come from the museum that affects the motivation of visitors to come, namely, promotion, service quality, and museum attractiveness including facilities, collections, and exhibition [2], [3]. The number of visits to the museum affects the performance of the museum, especially in the implementation

of the educational role which makes the number of visitors for its performance indicator to be achieved in the strategic plan [4][5].

However, during the COVID-19 pandemic, the targets formulated in the museum strategic plan could not be reached because the museum was closed to the public based on government policies that set restrictions on social activities in some public spaces during the pandemic. Likewise, in the new normal life, museums had to implement strict health protocols that restricted activities, and visits to museums contributed to people's interest in visiting museums. The study from home policy also affects student visits to museums to do field trips or conduct studies for assignments given by teachers or lecturers. As a result, the number of visits to the museum which was previously dominated by student visitors has decreased. The museum's role in education could not be carried out optimally during the COVID-19 pandemic.

Physical museums or traditional museums are no longer effective in carrying out educational roles during the COVID-19 pandemic and post-pandemic. The museum must be transformed into a digital museum by adopting information and communication technology that utilizes the sophistication of the internet so that the museum can be accessed anytime and anywhere by the public without direct interaction with the museum. But if the use of ICT is only for digitizing museums, for example, the development of museum information systems and digitizing museum collections [6], will lead to boredom so as not to attract repeat visits to the museum [7]. It is necessary to develop smart technology that can effectively be used by museums to optimize educational role, especially during the COVID-19 pandemic. Smart technology based on intelligent systems apply artificial intelligence (AI) can think and understand the user, presents information that is more attractive to users [8]. The transformation of a museum into a smart digital museum needs to be done as an effort to preserve art, culture, and history, especially in Indonesia which is rich in these resources. The museum educational role must be carried out with limited space and distance implemented as health protocol policies during a pandemic.

This study conducted a literature review to find the trend of applications that trigger the transformation of traditional museums into smart digital museums provides information for museum education post-pandemic recovery strategic planning.

II. THEORETICAL BACKGROUND

The theoretical background for this research is the condition of the current traditional museums in Indonesia which are affected by the COVID-19 pandemic in carrying out their

roles, especially education and the development of ICT that has been utilized by various modern museums in the world that can survive and carry out its roles during the pandemic although the physical museum is closed.

A. Traditional Museum for Education in Indonesia

Museums in Indonesia construct a strategic plan in carrying out the roles of museum education by determining performance indicator in the form of the number of people who appreciate the museum, namely the number of museum visitors, by holding several educational activities that attract visitors to come and study at the museum, organize a traveling museum, and provide information about museums and collections [9], [10]. These activities include conducting seminars and discussions, exhibitions, socialization in various print, electronic and social media, cooperation with various parties, and a traveling museum.

To bring visitors to the museum means to motivate the community to come. The motivation presented by the museum is an external factor, while the internal motivation comes from visitors. Museums can present external motivations including organizing interesting activities, arranging interesting and interactive museum collections and showrooms, human resources, as well as qualified facilities and infrastructure [11]. However, this strategy certainly requires adequate financing and human resources to optimize results. Museums in Indonesia are managed by the government and the private sector, which still have many problems with management costs [12], [13]. As a result, the potential of the museum cannot be optimized, especially for educational roles.

Collections are the museum's strength to attract visitors. Collections that are not well preserved, are not well organized will cause boredom and public reluctance to come or revisit the museum, especially millennials born in the digital era of the 21st century who do not recognize museum collections or history that seem ancient and unattractive to study because of their traditional nature. Meanwhile, the millennial generation has a modern lifestyle with digital technology [14], [15].

This condition shows that there are 435 museums in Indonesia [16] have problems in optimizing its roles for education if only measured by the number of visits to the museum. A museum with a low number of visits does not necessarily mean that the educational services provided are also low due to the museum's limitations. Learning in museums is carried out by exploring collections that motivate students to think and ask questions about museum collections and exhibits [17]. The current museum performance indicator is only measured based on the number of visits to the museum whose numbers are influenced by some factors that cannot be used during the COVID-19 pandemic because the number of visits has decreased due to museum closure policies and restrictions on face-to-face activities, especially education. The application of distance learning also affects student visits to museums which are the largest percentage of visitors to the museum, including at the SMB II Palembang museum in the 2018-2019 period. Students study from home need effective media to learn the museum and its collections with limitations of space and distance.

B. Technology Enhanced Learning in Museum

The traditional museum has a role in the conservation of the collection only. It needed to be transformed into a modern

museum that was following the development of the digital era as well as being able to meet the needs of the millennial generation who are familiar with digital technology so that they are interested in visiting and using the museum for various purposes [18]. A collection that is not well-managed will seem old-fashioned, unattractive, and boring to look at or study. This has an impact on the low interest in visiting or not an optimal use of the museum, one of which is influenced by external factors, namely the lack of museum facilities and services. Saturation of the monotonous presentation of exhibits and museum collections can lead to low visits to museums [19].

ICT promises convenience and more attractive attractions for visitors to modern museums than traditional museums. The provision of ICT-based service facilities to support the roles and functions of the museum has been implemented in many museums in the world and Indonesia, for example, the Taman Mini Indonesia Indah (TMII) insect museum [20] for example for multimedia use [21], [22], Museum Information System [6], [23], Augmented and Virtual Reality [24], [25], virtual guide [26], Edugame [27], [28], ticketing and museum exhibition [20].

The use of ICT in many museums has proven that ICT can provide easy access [29], presents a more interactive and interesting collection of information [30] where ancient objects and history seem to come back to life and the atmosphere can be felt by visitors through audio and visual skills of ICT [31]. Visitors are not only entertained and satisfied with the attractions presented at the museum through the use of ICT [18] but learning activities also become more fun through learning experiences [32] that are more interesting, interactive, and not boring so that students' understanding of history, art, and culture in museums can be more optimal than conventional learning methods [33] while increasing the competitiveness of museums in the tourism sector [34].

With the sophistication of AI technology and the industrial revolution 4.0, museums are not only required to switch to modern ICT-based but transformed to form a new model, namely the Smart Museum [35] which is part of the smart living dimension of the six dimensions of the smart city [36]. Smart museums make it easy for visitors to study and enjoy the collection and display of the museum optimally supported by the convenience and superiority of smart technology applied in the museum so that it has an impact on the quality of life of visitors and organizations, namely increasing the competitiveness of the museum and the economy of the city where the museum is located [37].

The smart museum is the transformation of a modern museum into a smart environment containing a collection of smart objects utilizing ICT that are connected and integrated so that they can present services supported by high-level intelligence technology [38] thus enabling communication between elements in the museum and visitors [39]. The smart museum adopting Internet of Thing (IoT) technology is designed with an architecture consisting of 3 (three) layers [39] which allows access to the museum's collections so that there is an interest in visiting the museum. The exchange of information that involves visitors makes the museum an interesting and fun place to gain knowledge.

III. RESEARCH METHODOLOGY

This study applies some procedures and methods in conducting literature studies [40] against the dataset that was built to answer research questions.

A. Research Questions

The research questions want to be answered through a literature review in this study are:

Q1: What is the trend of digital media development for museum education?

Q2: What intelligent system-based applications for museum education have been developed?

B. Dataset Development

The review begins with a bibliographic mapping of the research topic by formulating keywords related to the research title. Semantic search was done by using keywords in English to get more and more recent literature on research topics, namely "MACHINE LEARNING" AND "MUSEUM EDUCATION OR MUSEUM LEARNING". The keywords above are determined concerning the research problem for which we want to know the answer through a literature review. Machine learning was chosen as a keyword based on the algorithm's ability to understand users so that it intelligently presents interesting and interactive information for visitors or users of museum learning applications. Machine learning is part of artificial intelligence which plays an important role in building a "smart" construction enabling automation of intelligent recognition, monitoring, and maintenance [41], enriching the experience of visiting the museum [42]. Some machine learning algorithms have been developed in the last decade for various applications, one of which is in museums. The machine learning algorithm applied to the museum application makes the museum smart in understanding visitors by presenting collections, layouts, and service facilities according to visitor interests [43].

These keywords were then used to mine relevant literature metadata in the Google Scholar and Scopus databases using the Publish or Perish tool and succeeded in obtaining 1789 bibliographies consisting of 168 Scopus metadata and 1621 Google Scholar metadata. Based on the bibliographic metadata, bibliographic mapping was carried out in reviewing the state of the art research using the Vosviewer device with the result of an overlay visualization as shown in Fig. 1.

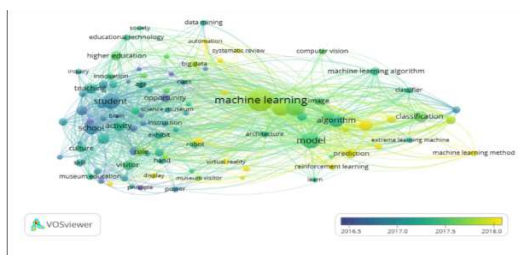


Fig. 1. Overlay of Bibliography Mapping

C. Literature Review Process

The next stage is to review the literature on search results by applying the screening criteria [52] to obtain literature relevant to the research problem. The inclusion and exclusion criteria were applied to the database, namely:

1. Selecting scientific publications in journals, proceedings, and books that will be reviewed while others are not;
2. Literature published in the last five years (2015-2021);
3. The literature discusses museum learning and or machine learning in education in the reviewed museum, while others will be issued in the literature review database;
4. Literature is then filtered based on title, keywords, abstract, and written content.

With these criteria, there are 11 (eleven) literature were reviewed as a full text. The process and results of database filtering using the criteria above are illustrated in Fig. 2,

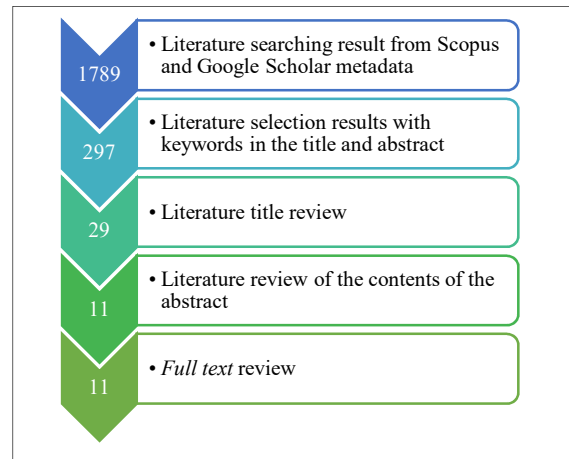


Fig. 2. Review Process

IV. RESULTS AND DISCUSSION

The results of a comprehensive review of the content of 11 (eleven) relevant literatures selected as a result of articles and journals on a dataset built according to the keywords used to answer the research questions are described in Table 1.

A. The trend of Museum Learning Application

The selection result dataset contains 11 literature consisting of 8 articles and 3 reputable scientific journals. From this dataset, a review was carried out and it was known that the distribution of museum education applications is illustrated in Fig. 3 and Fig. 4. This fact answers the research question of *Q1*. 72.72% of applications developed for education in the museum are based on games and augmented reality because both have been proven to be effective in providing a more interesting experience and added value to the museum's collections and exhibits to reduce boredom because of the monotonous museum environment. Both can provide different visualizations and a more interesting experience employing interactions that are not possible in a real museum environment so that it attracts users to take advantage of game applications and or Augmented Reality for education in museums [44]. Furthermore, it is also known that applications based on mobile devices or websites were the most developed, namely 72.72% of all applications for education in museums as the search results in this study (Fig. 5) where robot technology began to be developed for museum education applications in 2016- 2020.

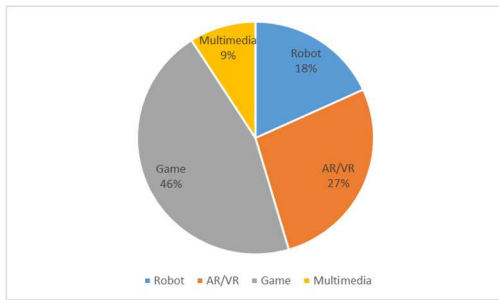


Fig. 3. The applications trend for museum education

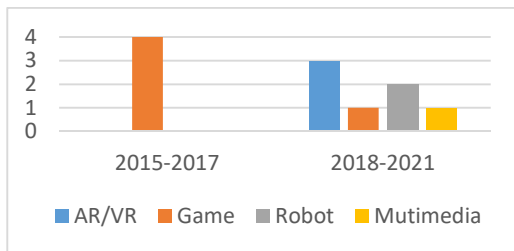


Fig. 4. Museum education app trends per period

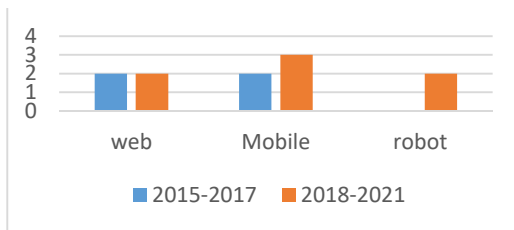


Fig. 5. The trend of application base per period

Mobile technology and websites have the advantage that the use of smart devices has become part of the lifestyle with the support of internet technology made access to information for education can be anywhere and anytime so that applications have begun to develop rapidly along with the development of the internet in the last five years.

Q2 was answered with the discovery of the fact that modern museums based on digital technology have begun to transform into smart application-based learning for the last 3 (three) years in which smart robot technology that applies machine learning and information retrieval information systems that also applied machine learning was developed for interactive and smart educational purposes to reduce the boredom of the monotonous museum collections and exhibits. But the review results in Table 1 show that the museum app has not integrated learning outcomes as part of the apps development framework so that the measurement of learning outcomes cannot be directly measured with the support of intelligent computing that has the ability to analyze user profiles.

B. Museum Education Recommendation and Challenged for Post Pandemic Recovery

The use of ICT in museums, for example, the development of a website-based digital museum with an attractive interface design and content, has been proven to affect the interest in visiting physical museums [45]. ICT enable the museum in Indonesia to carry out its roles virtually during the COVID-19 pandemic[23], [25], [46] where the

tourism in Indonesia is also affected by restrictions on movement and distance to reduce the spread of COVID-19 [47]. The transformation of the museum into a modern, ICT-based museum enables the effectiveness of reducing the direct contact of visitors with the museum environment so that they safely learn and enjoy the museum's collections, layouts, facilities, and services in a new normal way.

The challenge faced in carrying out a smart digital transformation of museum learning to deal with post-pandemic recovery is that an appropriate conceptual framework is needed to develop museum learning applications so that learning objectives, as well as museums' roles for education, can be reached even with limited access to physical museums during the current pandemic and post-pandemic. The rapid development of the internet to produce big data is also a challenge in processing it into information to present attractive and interactive displays according to museum visitors' interests. It might become the motivation for repeat visits having an impact on the number of visits and post-pandemic optimization of museum educational roles, especially in Indonesia.

Smart apps apply artificial intelligence that effectively understand users to present attractive and interactive app features. This condition makes it a challenge for developers to develop algorithms applied to smart systems for learning in museums. Smart applications for learning in museums must be able to attract users' interest while increasing their knowledge about collections and museums.

In the post-pandemic period, museums must be able to carry out their roles even with limited space and distance. Adjustments to new normal, a museum is recommended to transform into smart digital museums integrating ICT for enabling museum education and improve museum educational performance, which decreases when the pandemic and returns to normal or even expected to increase after COVID-19 pandemic.

V. CONCLUSIONS

This literature study research aims to observe the trend of smart digital media development for museums education purposes needed for post COVID-19 pandemic recovery. The sophistication of ICT and the current development of the internet have the advantage of overcoming the constraints of space and distance restrictions imposed on physical museums during the pandemic to comply with health protocols.

The literature review results showed that applications based on mobile devices or websites were mostly developed 72.72% of all apps for education in modern museums and museums began to transform into a smart digital museum by implementing a machine learning-based smart system in the last three years. Applications that are trending for education in museums are categorized as games, augmented or virtual reality, robotics, and information retrieval systems. These apps enable less contact with museum resources including guides, collections, and exhibition facilities, and effectively eliminates space and distance barriers that arise in physical museums. For strategic planning recommendation, smart digital transformation is urgent for traditional museums existence and carries out their education roles for post COVID-19 pandemic recovery. The challenges faced in this transformation provides opportunities for the development of museum learning research for museum apps in the post-pandemic.

TABLE 1. LITERATURE REVIEW RESULTS

Ref	App	App Base	Machine Learning	Strength	Weakness
[48]	Robot	Robotic	Yes	It promises learning in museums will not be boring, more interactive, interesting, and fun.	High development costs for a non-profit museum. Did not discuss the domain of learning in design and evaluation
[28]	Augmented Reality	Mobile	No	The collection is presented in 3D, based on Marker and GPS	Only presents information about the museum. There was no evaluation of user knowledge
[49]	Game	Mobile	No	Adopting Virtual Reality, games involve physical and emotional users which are part of the affective and psychomotor domains	There was no evaluation of user knowledge, it did not explain the realm of learning directly in game design
[50]	Multimedia Information Retrieval System	Mobile & Website	Yes	Information retrieval based on image content captured by visitors in the museum environment. Information was presented to visitors regarding the cognitive domain	Application to support museum operations was like a digital guide, not specifically for education. There was no evaluation of user knowledge
[51]	Information System, AR/ VR	Website	No	Discussed the environment and facilities for technology applications in museums that are effective for supporting learning	Not specifically explained each use of applications for learning in terms of the realm of learning
[52]	Augmented Reality	Website	No	Evaluation of learning through Augmented reality applications was carried out in the cognitive domain	Does not involve indicators of learning success at the application design stage
[53]	Robot	Robotic	No	Involving the domain of learning in the robot development plan	A design, not yet tested the effectiveness of implementation. Development costs are predicted to be high for the museum application as a non-profit organization
[54]	Game Video 360	Website	No	Presenting real dynamic and interactive images with users in the form of 360 video-based games	There was no evaluation in the realm of learning. The application does not provide recommendations for ordinary users so that they are interested exploring the game
[55]	Game	Mobile	No	Games are effective to support learning in museums in the cognitive, affective, and psychomotor domains	Did not discuss the application of machine learning algorithms in educational games
[17]	Game	Website	No	Knowledge of exhibits and museum collections of real pictures was given through an interesting and fun game	Did not discuss learning outcome through the Edugame application that was built
[56]	Game	Mobile	No	Discussed the features of learning activities according to the learning objectives that users want. Tests were carried out in the cognitive realm and found that games were effective in making students spend more time in museums	Did not address the three domains of learning in design or evaluation. Games in the form of 2D were less attractive to users outside the museum because they were not the same as showcases and real collections

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REFERENCES

[1] N. Trisnawati and N. Idaman, "Motivasi Pengunjung Mengunjungi Museum di Kawasan Kota Tua Jakarta," *Ikra-Ith Ekon.*, vol. 2, no. 1, pp. 125–136, 2019.

[2] I. Budiando, A. Type, A. Date, A. Date, R. Article, and P. Date, "Relationship between Service Quality and Revisit Intention of Museum Travelers in Jakarta: Mediation Effect of Visitor Satisfaction," *Int. J. Soc. Sci. Innov. Educ. Technol.*, vol. 1, no. 4, pp. 458–462, 2020.

[3] Tattawan Duantrakoonsil, Hae Young Lee, and Earl L. Reid, "Museum Service Quality, Satisfaction, and Revisit Intention: Evidence from the Foreign Tourists at Bangkok National Museums in Thailand," *Culin. Sci. Hosp. Res.*, vol. 23, no. 6, pp. 127–134, 2017, doi: 10.20878/cshr.2017.23.6.014014014.

[4] W. Pradana, *Museum Benteng Vredenburg Yogyakarta*, no. 6, 2019.

[5] M. P. N. Proklamasi, "Perjanjian Kinerja Tahun 2019," 2019.

[6] S. Puspasari and L. Marnisah, "Implementasi E-Museum Dr. Ak. Gani Palembang," *J. Abdimas Mandiri*, vol. 3, no. 2, pp. 120–130, 2019, doi: 10.36982/jam.v3i2.827.

[7] B. Li, "The Influence of Brand Experience on People's Revisit and Purchase Intention in the Context of China's Museum," *Am. J. Ind. Bus. Manag.*, vol. 08, no. 03, pp. 563–578, 2018, doi: 10.4236/ajibm.2018.83037.

[8] S. A. Marchenkov, A. S. Vdovenko, O. B. Petrina, and D. G. Korzun, "Smart museum of everyday life history in Petrozavodsk State University: Software design and implementation of the semantic layer," *Conf. Open Innov. Assoc. Fruct*, pp. 224–230, 2018, doi: 10.23919/FRUCT.2017.8250186.

[9] M. Nasional, "Renstra museum nasional tahun 2015-2019 | 1," no. 1, pp. 1–46, 2019.

[10] D. J. Kebudayaan, "Rencana strategis museum benteng vredenburg yogyakarta tahun 2020 - 2024," no. 6, 2020.

[11] D. Girsang and R. Nabila, "Potensi dan Pengembangan Museum Uang Sumatera Sebagai Objek dan Daya Tarik Wisata Sejarah di Kota Medan," *Akomodasi Agung*, vol. 7, no. 1, 2020.

[12] A. N. Akbar S, A. Alaydrus, and N. Hasanah, "Peran dinas pemuda, olahraga dan pariwisata dalam meningkatkan pariwisata museum sadurengas di kecamatan pasir belengkong kabupaten paser," *eJournal Ilmu Pemerintah.*, vol. 7, no. 2, pp. 635–646, 2019.

[13] Sa. Yendra, "Museum dan Galeri (Tantangan dan Solusi)," *J. Tata kelola Seni*, vol. 4, no. 2, pp. 103–108, 2018.

[14] V. Gaffar, "Pengaruh Strategi Positioning Museum Terhadap Kunjungan Wisata Edukasi di Kota Bandung (Survey Segmen Pasar Generasi Y)," vol. 1, no. 1, pp. 15–32, 2011.

[15] R. V. Nuncio, "Benchmarking ICT for education in Japan: Best practices, trends, challenges and lessons learned for Philippine ICT-based education & development," *Asia-Pacific Soc. Sci. Rev.*, vol. 20, no. 2, pp. 136–148, 2020.

[16] K. P. dan Kebudayaan, "Statistik Kebudayaan 2019," 2019.

[17] C. Chang, M. Chang, and J. S. Heh, "National Palace Museum Adventure—A Mobile Educational Role-Playing Game for Museum Learning," ... *Learn. Environ. Technol.*, 2015, [Online]. Available: https://link.springer.com/chapter/10.1007/978-3-662-44659-1_11.

[18] H. Chen and C. Ryan, "Transforming the museum and meeting visitor requirements: The case of the Shaanxi History Museum," *J. Destin. Mark. Manag.*, vol. 18, no. April, p. 100483, 2020, doi: 10.1016/j.jdmm.2020.100483.

- [19] C. Antón, C. Camarero, and M. J. Garrido, "A journey through the museum: Visit factors that prevent or further visitor satiation," *Ann. Tour. Res.*, vol. 73, no. September, pp. 48–61, 2018, doi: 10.1016/j.annals.2018.08.002.
- [20] N. Andanwerti, "Applying Interactive Exhibition in Museum of Insects, Taman Mini Indonesia Indah Jakarta," ... *Int. Conf. Appl. ...*, 2020, [Online]. Available: <https://www.atlantispress.com/proceedings/ticash-20/125948077>.
- [21] L. Danyun and C. Y. Jiun, "Historical cultural art heritage come alive: Interactive design in Taiwan palace museum as a case study," *Proc. 2016 Int. Conf. Virtual Syst. Multimedia, VSMM 2016*, 2016, doi: 10.1109/VSMM.2016.7863187.
- [22] Y. Luo, "On the Information Application of Multimedia Technology in Museum," *Proc. - 2020 5th Int. Conf. Commun. Image Signal Process. CCISP 2020*, pp. 299–303, 2020, doi: 10.1109/CCISP51026.2020.9273468.
- [23] Tubagus, W. Hadi, Y. Maryuni, A. Nurhasanah, and D. Willdianti, "Pemanfaatan Virtual Tour Museum (VTM) dalam Pembeajaran Sejarah di Masa Pandemi Covid-19," in *Seminar Nasional Pendidikan FKIP*, 2020, vol. 3, no. 1, pp. 402–408.
- [24] A. Marinda and Y. Efendi, "Aplikasi Museum Sang Nila Utama Berbasis Mobile dengan Teknologi 3D Augmented Reality," vol. 3, no. 1, 2019.
- [25] S. Puspasari, N. Suhandi, and J. N. Iman, "Augmented Reality Development for Supporting Cultural Education Role in SMB II Museum during Covid-19 Pandemic," *2020 5th Int. Conf. Informatics Comput. ICIC 2020*, 2020, doi: 10.1109/ICIC50835.2020.9288619.
- [26] T. Teslyuk, "A mobile museum guide application," *CEUR Workshop Proc.*, vol. 2631, pp. 314–326, 2020, [Online]. Available: <https://www.scopus.com/inward/record.uri?partnerID=HzOxMe3b%5C&scp=85088879409%5C&origin=inward>.
- [27] I. Paliokas and S. Sylaiou, "The use of serious games in museum visits and exhibitions: A systematic mapping study," *2016 8th Int. Conf. Games Virtual Worlds Serious Appl. VS-Games 2016*, 2016, doi: 10.1109/VS-GAMES.2016.7590371.
- [28] C. M. Bolognesi and A. A. D. Aiello, *Learning through serious games: a digital design museum for education*. re.public.polimi.it, 2020.
- [29] G. A. Manu, "Scan QR Code untuk Mengenal Benda-Benda Bersejarah di Museum," *J. Pendidik. Teknol. Inf.*, vol. 2, no. 1, pp. 15–19, 2019, doi: 10.37792/jukanti.v2i1.19.
- [30] P. Diaz, A. Bellucci, and I. Aedo, "Enabling social interaction in the museum through the Social Display Environment," pp. 345–348, 2016, doi: 10.1109/digitalheritage.2015.7413898.
- [31] Y. S. Rosid, "Penyajian Ruang Pameran Sejarah Berteknologi Augmented Reality pada Museum Gedung Sate Bandung," *Waca Cipta Ruang (Jurnal Ilm. Desain Inter.)*, vol. 6, no. 1, 2020.
- [32] S. Puspasari, N. Suhandi, and J. N. Iman, "Enhancing The Visitors Learning Experience in SMB II Museum Using Augmented Reality Technology," in *International Conference on Electrical Engineering and Informatics (ICEEI)*, 2019, pp. 296–300.
- [33] P. P. Li and P. L. Chang, "A study of virtual reality experience value and learning efficiency of museum-using shihsanhang museum as an example," *Proc. 2017 IEEE Int. Conf. Appl. Syst. Innov. Appl. Syst. Innov. Mod. Technol. ICASI 2017*, pp. 1158–1161, 2017, doi: 10.1109/ICASI.2017.7988391.
- [34] I. L. Pop and A. Borza, "Technological innovations in museums as a source of competitive advantage," in *d International Scientific Conference SAMRO*, 2016, no. 76811, [Online]. Available: <https://mpira.ub.uni-muenchen.de/id/eprint/76811>.
- [35] R. Nikitha and S. Malathi, "Survey on smart museum using iot," *Int. J. Sci. Technol. Res.*, vol. 8, no. 10, pp. 831–834, 2019.
- [36] L. Vandercrussse, C. Buts, and M. Dooms, "A typology of Smart City services: The case of Data Protection Impact Assessment," *Cities*, vol. 104, no. July 2019, p. 102731, 2020, doi: 10.1016/j.cities.2020.102731.
- [37] J. Mondschein, A. Clark-Ginsberg, and A. Kuehn, "Smart cities as large technological systems: Overcoming organizational challenges in smart cities through collective action," *Sustain. Cities Soc.*, vol. 67, no. August 2020, p. 102730, 2021, doi: 10.1016/j.scs.2021.102730.
- [38] D. Korzun, A. Varfolomeyev, S. Yalovitsyna, and ..., "Semantic infrastructure of a smart museum: toward making cultural heritage knowledge usable and creatable by visitors and professionals," *Pers. Ubiquitous ...*, 2017, [Online]. Available: <https://link.springer.com/content/pdf/10.1007/s00779-016-0996-7.pdf>.
- [39] A. Chianese and F. Piccialli, "Designing a smart museum: When cultural heritage joins IoT," *Proc. - 2014 8th Int. Conf. Next Gener. Mob. Appl. Serv. Technol. NGMAST 2014*, no. September, pp. 300–306, 2014, doi: 10.1109/NGMAST.2014.21.
- [40] J. Radianti, T. A. Majchrzak, J. Fromm, and I. Wohlgenannt, "Computers & Education A systematic review of immersive virtual reality applications for higher education : Design elements , lessons learned , and research agenda," *Comput. Educ.*, vol. 147, no. November 2019, p. 103778, 2020, doi: 10.1016/j.compedu.2019.103778.
- [41] Y. Xu, Y. Zhou, P. Sekula, and L. Ding, "Machine learning in construction : From shallow to deep learning," *Dev. Built Environ.*, vol. 6, no. April 2020, p. 100045, 2021, doi: 10.1016/j.dibe.2021.100045.
- [42] G. Ioannakis, L. Bampis, and A. Koutsoudis, "Exploiting artificial intelligence for digitally enriched museum visits," *J. Cult. Herit.*, vol. 42, pp. 171–180, 2020, doi: 10.1016/j.culher.2019.07.019.
- [43] S. Puspasari and E. Ermatita, "A Survey of Data Mining Techniques for Smart Museum Applications," *J. Inform.*, vol. 9, no. 1, pp. 33–42, 2021, doi: 10.5772/53989.
- [44] S. Puspasari, N. Suhandi, and J. N. Iman, "Evaluation of Augmented Reality Application Development for Cultural Artefact Education," *Int. J. Comput.*, vol. 20, no. 2, pp. 237–245, 2021, doi: 10.47839/ijc.20.2.2171.
- [45] J. Pallud and D. W. Straub, "Effective website design for experience-influenced environments: The case of high culture museums," *Inf. Manag.*, vol. 51, no. 3, pp. 359–373, 2014, doi: 10.1016/j.im.2014.02.010.
- [46] A. Firdaus, I. K. Feby, P. Jaya, W. Swandi, and I. A. Gede, "Manfaat Museum Virtual Google Art and Culture Sebagai Media Digital untuk Bali Pada Masa Pandemi (Benefits of the Google Art and Culture Virtual Museum as a Digital Media for Bali during the Pandemic)," in *Seminar Nasional Desain*, 2021, vol. 1, pp. 1–8.
- [47] A. Maharani and F. Mahalika, "New Normal tourism Sebagai Pendukung KEthanan Ekonomi Nasional Pada Masa Pandemi," *J. Kaji. Lemhanas RI*, vol. 8, no. 2, 2020.
- [48] J. Kasperiniene and I. Tandzegolskiene, "Smart learning environments in a contemporary museum: a case study," *J. Educ. Cult. ...*, 2020, [Online]. Available: http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.ojs-doi-10_15503_jecs2020_2_353_375.
- [49] P. Haryani and J. Triyono, "The Designing of Interactive Learning Media at Yogyakarta's Sandi Museum Based on Augmented Reality," *JOIV Int. J. Informatics ...*, 2020, [Online]. Available: <http://www.joiv.org/index.php/joiv/article/view/157>.
- [50] H. Candello, M. Pichiliani, M. Wessel, and ..., "Teaching Robots to Act and Converse in Physical Spaces: Participatory Design Fictions with Museum Guides," *Proc. ...*, 2019, [Online]. Available: <https://dl.acm.org/doi/abs/10.1145/3363384.3363399>.
- [51] A. Poce, F. Amenduni, C. De Medio, M. Valente, and M. R. Re, "Adopting Augmented Reality to Engage Higher Education Students in a Museum University Collection: the Experience at Roma Tre University," *Information*, 2019, [Online]. Available: <https://www.mdpi.com/2078-2489/10/12/373>.
- [52] Z. Sun, K. Wang, and Z. Li, "Construction of Educational Resources and Design of Learning Activities in Facilitating Museum Education," *2019 Int. Jt. Conf. ...*, 2019, [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/9066377/>.
- [53] G. Ioannakis, L. Bampis, and ..., "Artificial Intelligence as a Low-Cost Solution For Museum Visit Digital Content Enrichment: The Case of The Folklore Museum of Xanthi," ... *Archives of the ... pdfs.semanticscholar.org*, 2019, [Online]. Available: <https://pdfs.semanticscholar.org/7492/df90d3973cb3417b49352f96a66f26d711f5.pdf>.
- [54] I. Malegiannaki and Daradoumis, "Analyzing the educational design, use and effect of spatial games for cultural heritage: A literature review," *Comput. Educ.*, vol. 108, pp. 1–10, 2017, doi: 10.1016/j.compedu.2017.01.007.
- [55] L. Argyriou, D. Economou, and ..., "360-degree interactive video application for Cultural Heritage Education," ... *Learning ... westminsterresearch.westminster.ac ...*, 2017, [Online]. Available: <https://westminsterresearch.westminster.ac.uk/item/q28q0/360-degree-interactive-video-application-for-cultural-heritage-education>.
- [56] Y. N. Lien, "Mobile edutainment system--National Palace Museum as an example," *2015 3rd Int. Conf. Futur. Internet ...*, 2015, [Online]. Available: <https://ieeexplore.ieee.org/abstract/document/7300873/>.