

A Review on Technological Innovation in Traditional Musical Instruments: Methodology, Challenges, and Public Acceptance

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Abstract

The rapid development of modern technology has to some extent affected the interest of the public toward traditional musical instruments and thus many studies discovered have focused on the innovation of the instruments. This review aims to investigate and analyze past and current studies on the exploration of technological innovation in the field of traditional musical instruments. The selected studies included in this review are the ones that focus on Asia's traditional musical instruments which still maintain their traditional values, in a modern way and almost all the research uses the qualitative method to produce the outcome. There are three concepts of innovation found among the past studies and one of them is application tools with interactive interface and the lowest cost so far. Next, is the replicated instrument which replacing real musical instruments with other objects that more lighter, cheaper and portable with a shape that might be almost the same as the real instrument. Lastly, the use of the real instrument undergoes some modification to make it played automatically without real performers and this will help in the form of exhibits or performing. In this paper, the results are discussed in terms of the methodology used to obtain data, public acceptance toward the innovation, and future development of the studies.

Keywords: Innovation, Media Art, Robotic, Traditional Music

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Introduction

Musical instruments nowadays are not left behind in the use of technology in line with the advancement of technology and media today. Some musicians have innovated musical instruments using technology or can be called robotic musical instruments. Either to make the performance more interesting, create a band that can play with them forever, teaching or have health problems (Kapur, 2005). The innovation mostly focused on western or modern musical instruments but rarely on traditional instruments (Leng, Norowi & Jantan, 2018; Damklian, Thongnuan & Chanlert, 2012) and most have succeeded in performing the innovation instruments. Therefore, the need for technological innovation in traditional musical instruments is necessary which can connect the past with the future, help in preserving, create more opportunities to show them on the international level and for education purposes. Although there are traditional musical instruments that have been combined with technology, most of them use a virtual application that uses the least cost and easy to develop and use. Some studies show that the use of such technology as an educational approach has positive feedback on user's interest, understanding, and knowledge of traditional musical instruments (Simeon, 2015; Tan & Lim, 2018; Wiguna, 2019). Research conducted on the use of technology on real Asia's traditional instruments is limited. Thus, a scoping review was performed to study and understanding the published work that using real instruments besides the other two concepts found among the review studies which are interactive applications and replicated instruments.

Methods

Design

This scoping review uses the methodology framework by Arksey and O'Malley (2005) which to summarize research findings and identify the research gaps in the existing studies. The framework consists of five stages for conducting the scoping review, which is identifying the research questions, identifying relevant studies, study selection, charting the data, and collating, summarizing, and reporting the results.

Identifying the Research Questions

The review studies are selected based on few research questions, "How technological innovation can be applied to traditional instruments?" and "What are public responses toward the use of technology in traditional musical instruments?". Where some old people could not accept the change of their traditions.

Identifying Relevant Studies

Searching for research evidence has been done using electronic sources and was conducted in the database Scopus, Science Direct, Google Scholar, and Research Gate since October 2019. Each database was searched using few terms; technological innovation, traditional musical instruments, augmented musical instruments, robotic, and preservation in two languages; Malay and English. Besides that, searching for relevant studies also done using reference list and citation from the database searches result.

Study Selection

Initial search has found many irrelevant studies. Besides using the research question to exclude the unnecessary studies, the problem statement was identifying just from the abstract, which is focused on the extinction, folk instruments, and the least interesting instruments in any field such as education, performance, and exhibition. After excluding those studies, there is left 12 articles and one thesis for fully reading.

Charting the Data

This stage is for synthesizing and interpreting data through shifting, charting, and sorting material according to key issues and themes (Arksey & O'Malley, 2005). Each article and thesis found are categorized into a table by title, author, year, country, aim, participant, method, and results as shown in Table 1.

Collating, Summarizing, and Reporting Results

Among those articles, not all studies were conducted in Asia even though they discussed Asia's traditional musical instruments. The countries where the studies were conducted are Malaysia, Indonesia, Thailand, South Korea, China, and the United States. Among the studies, there is three concepts of innovation found which is application tools with interactive interfaces, replicated instruments that do not use original instruments and those that use original instrument but with modifications. In six of the 13 studies (Phunsa, S., 2014; Trangansari et al., 2013; Permana et al., 2019; Tan et al., 2018; Leng et al., 2018; Ahmad Faris, 2012) is the innovation using application tools. Among that, two of the studies (Phunsa, S., 2014; Tan et al., 2018) use Augmented Reality (AR) to introduce their instruments, one study (Trangansari et al., 2013) developed using Virtual Reality (VR), another one (Ahmad Faris, 2012) use 2D Mobile Application, one study (Permana et al., 2019) use AR with Leap Motion technology and the last one (Leng et al., 2018). using Leap Motion as a musical instrument controller. Other than that, three articles (Pardue et al., 2011; Wiriadjaja, A., 2013; Oh et al., 2013) innovated replicated instruments and the other articles (Zhong et al., 2015; Putra et al., 2019; Simeon, J.J.C., 2015; Maulindar et al., 2018) are still use original instruments with some modifications. The design and methodology to describe the studies mostly use qualitative method and some described the quantitative method, prototyping methodology, observation, purposive sampling method, and questionnaire.

Results

From the analysis of this scoping review on technological innovation in traditional musical instruments, three themes were presented which are the various design and methodology, the purpose field area, and reported outcomes of the studies.

The Design and Methodology

Among 11 of the studies, the authors conducted using the qualitative method to collect data from sample (Phunsa, S., 2014; Trangansari et al., 2013; Permana et al., 2019; Tan et al., 2018; Leng et al., 2018; Zhong et al., 2015; Simeon, J.J.C., 2015; Wiriadjaja, A., 2013; Oh et al., 2013; Putra et al., 2019; Maulindar et al., 2018), four out of those 11 are also used observation method (Tan et al., 2018; Simeon, J.J.C., 2015; Wiriadjaja, A., 2013; Oh et al., 2013) where Oh et al. (2013) described their research using observation method through the

exhibition. and a study among that also used the quantitative method (Trangansari et al., 2013). Four studies described using prototyping methodology (Pardue et al., 2011; Putra et al., 2019; Ahmad Faris, 2012; Maulindar et al., 2018) where they implemented because the project keeps changing or improving as the project progress until it is ready to test users, but one of the studies do not describe the target audience (Putra et al., 2019). While Ahmad Faris (2012) also used the qualitative method to collect evaluation data from smartphone users and musicians. One study was using the purposive sampling method by obtained opinions from the samples (Phunsa, S., 2014).

| Title / Author / Year / Country | Participants | Method / Design | Objectives | Results |
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| Applying Augmented Reality to Promote Traditional Thai Folk Musical Instruments on Postcards (Phunsa, S., 2014) (Thailand) | 45 Undergraduate students age level 19-20 of New Media department at Mahasarakham University | Qualitative case study Purposive Sampling method | To promote Thai folk musical instruments on smart devices. To increase digital opportunity and distribution for access to digital society. To create and find the most suitable technology platform for Thai culture. | Positive responses toward promoting Thai cultural preservation, suitable video clips and sounds, creativity, attractive 3D models, and beautiful graphic displays |
| The Edutainment of Online Thai Traditional Musical 3D Virtual reality Museum (Trangansri, et al., 2013) (Thailand) | 40 Elementary students at Chongburi, Thailand 5 experts | Qualitative case study Quantitative user data | To develop and evaluate the satisfaction of the edutainment. To support online platforms. | The overall quality of the system design was good and the degree of clarity was rated higher than target levels. The system presents an excellent environment for learning. |
| Development of Augmented Reality Based Gamelan Simulation with Leap motion Control (Permana et al., 2019) (Indonesia) | 5 Smartphone users | Qualitative user data | To introduce gamelan and how to play it by utilizing AR and Leap Motion to smartphone users. To measure and discover the essential parameter in this simulation. | Need to have appropriate distance and brightness to get a better result. The technology can be an allurements for the users that never try or know gamelan before. |

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| <p>Malaysian Music Augmented Reality (MMAR): Development of Traditional Musical Instruments Using AR (Tan et al., 2018)</p> <p>(Malaysia)</p> | <p>10 Primary school students with an average age of 7.9 and never in contact with AR</p> <p>2 Musical teachers</p> | <p>Qualitative user data</p> <p>Observation</p> | <p>To promote Malaysian music education especially the traditional musical instruments to the young generation by exploiting the technology from AR.</p> <p>To develop an AR application by enriching digital musical instruments to help the student learn it anywhere and anytime.</p> | <p>End-users face difficulty scanning the maker due to inadequate light.</p> <p>The majority of the student agreed to use the application as starting to learn music education.</p> <p>Able to entertain students which could help in teaching.</p> |
| <p>Virtual Kompang: Mapping In-Air Hand Gestures for Music Interaction Using Gestural Musical Controller (Leng et al., 2018)</p> <p>(Malaysia)</p> | <p>15 Respondents who experienced in using hand tracking controllers</p> | <p>Qualitative user data</p> | <p>To elicit natural gestures end-user using quessability study.</p> <p>To imitate the physical characteristics of Kompang into a digital musical interface.</p> <p>To preserve in the form that is more easily accessed by contemporary users.</p> | <p>195 gestures were generated, grouped into 60 groups.</p> <p>Two sets of hand gestures were presented: consensus set and other gestures.</p> <p>Users preferred the consensus set in terms of goodness and ease to use.</p> |
| <p>Virtual Gamelan Mobile Application (Ahmad Faris, 2012)</p> <p>(Malaysia)</p> | <p>10 Smartphone users</p> <p>5 Gamelan musicians</p> | <p>Prototyping</p> | <p>To revive and expose gamelan to the public and preserve the traditional art form.</p> <p>To explore the use of the multi-touch capability of mobile device interface for playing gamelan.</p> <p>To evaluate user experience with the application.</p> | <p>Has exposed gamelan music to people unaware of its existence.</p> <p>Successfully emulated as a digital form for the mobile device market.</p> <p>Better quality of sound and graphics.</p> |

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| <p>Gamelan ElektriKA: An Electronic Balinese Gamelan (Pardue et al., 2011)</p> <p>(United States)</p> | <p>Performance audience over 5000</p> | <p>Prototyping</p> | <p>To reduce the transportation challenges of the previously large and heavy ensemble.</p> <p>To create an opportunity for wider audiences to experience Gong Kebyar's enchanting sound.</p> | <p>Successfully debuted to the audience at Lincoln Center.</p> <p>Second performance at MIT's Kresge – improve sensitivity and reliability.</p> <p>Able to meet the musical goals: variable tunings, wider sound palette, and easier transportation.</p> |
| <p>Gamelan Sampul: laptop Sleeve Gamelan (Wiradjaja, A., 2013)</p> <p>(United States)</p> | <p>Exhibition visitors</p> <p>Gamelan players</p> | <p>Qualitative data</p> <p>Observation</p> | <p>To practice playing Javanese gamelan without a full set of instruments.</p> <p>To develop a set of portable mobile tools for learning, recording, and performing classical Javanese gamelan music.</p> | <p>Act as an informational device that introduces non-Western music to children who have not heard it before.</p> <p>Gamelan players want to utilize it to play music with each other over a network.</p> |
| <p>The Kinetic Xylophone: An Interactive Musical Instruments Embedding Motorized Mallets (Oh et al., 2013)</p> <p>(South Korea)</p> | <p>Common spectators, children, hand injured spectator, learning disability person</p> | <p>Qualitative case study</p> <p>Observation</p> | <p>To develop a sound installation that reacts to performers without traditional executions.</p> <p>To play music with motorized mallets by gestures from spectators.</p> | <p>Due to the separated construction of each model, performers can play in the range of two octaves polyphonically.</p> <p>Presents characteristics of random access and interactivity as a form of digital kinetic art.</p> |

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| <p>ChinAR: Facilitating Chinese Guqin Learning Through Interactive Projected Augmentation (Zhong et al., 2015) (China)</p> | <p>12 Young adult amateurs with experience of Guqin learning range from 6 – 18 months 2 Novice players 2 Senior players</p> | <p>Qualitative data</p> | <p>To provide an easy and effective way of learning Guqin. To design a supplement to the traditional tablature and courses.</p> | <p>Beginner: show effectiveness in reducing practicing time with better outcome and memorization. Novice: boosted their interest and confidence in fulfilling their desire to play the famous tune. Senior: with the hope to broaden their performing range and expression.</p> |
| <p>Perancangan Kontrol Alat Musik Angklung Menggunakan Arduino, ESP8266 and Android (Putra et al., 2019) (Indonesia)</p> | <p>Not described</p> | <p>Qualitative case study Prototyping</p> | <p>To design controller Angklung using Arduino, Wi-Fi, and Android. To help promote Angklung as a traditional musical instrument.</p> | <p>Using technology that can communicate and change data through the Internet. Can connect to a server and play music automatically. Attractive interface design and easy to understand.</p> |
| <p>Prototype Alat Musik Tradisional Melalui Simulasi Bermain Saron (Maulindar et al., 2018) (Indonesia)</p> | <p>The public that wants to learn to play Saron</p> | <p>Qualitative case study Prototyping</p> | <p>To design a prototype that plays automatically to learn Saron.</p> | <p>Using motor servo for each plate that performed movement according to the tone of the song. The prototype only can play one song and using Saron only among the set of gamelan.</p> |

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| <p>The U9 Xylophone: An Innovation in Music Classroom Teaching (Simeon, J. J. C., 2015)</p> <p>(Malaysia)</p> | <p>Children under nine years old</p> | <p>Qualitative study</p> <p>Observation</p> | <p>To promote the nationwide utilization of the local innovative product for the teaching of music.</p> | <p>Players can remove unwanted bars and easily strike the correct bar.</p> <p>Children enjoyed playing it.</p> <p>Children responded positively and easy to play by the youngster.</p> |
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Table 1: Overview of included literature.

The Purpose Field Area

Five out of the 13 studies were designed for promotion and to introduce the traditional musical instruments to the public (Phunsa, S., 2014; Permana et al., 2019; Putra et al., 2019; Ahmad Faris, 2012; Leng et al., 2018). Phunsa, S., (2014) promoted Thailand's traditional musical instruments by using smart devices with the help of video clips and sounds, 3D models, and graphic display. While Permana et al. (2019) introduce gamelan and how to play like the real instrument for smartphone users. Although Putra et al. (2019) promoting Angklung as a traditional musical instrument, their article only presented until the end of the development process which might not share yet the feedback from any participants. Ahmad Faris (2012) wants to exposed gamelan more to the public through a mobile application to revive the traditional gem. The last one, although Leng et al. (2018) designed Virtual Kompang without using the original instrument, its purpose still to preserve the traditional musical instrument in a form that is easier to approach by the contemporary user. Five of the studies were described in the education area of traditional musical instruments (Trangansari et al., 2013; Tan et al., 2018; Zhong et al., 2015; Maulindar et al., 2018; Simeon, J.J.C., 2015). Those studies were created to provide an easy and effective way for learning and teaching purposes which most traditional musical instruments not easy to learn. Pardue et al. (2011) are not local peoples of where the gamelan comes from but they eager to perform the replicated instruments that use the original shape in front of the large audience to create an opportunity for them to experience the instrument’s enchanting sound. The purpose of Kinetic Xylophone (Oh et al., 2013) is within the exhibition field area where the final prototype is being exhibited in a place which not described in their article. Lastly, Wiriadjaja, A. (2013) described the project purpose in both performance and exhibition area which also a tool for learning classical Javanese gamelan music instruments.

Reported Outcomes

Almost all the studies give a result based on participant experiences as reported in several articles (Phunsa, S., 2014; Trangansari et al., 2013; Tan et al., 2018; Leng et al., 2018; Wiriadjaja, A., 2013; Zhong et al., 2015; Ahmad Faris, 2012; Simeon, J.J.C., 2015) and among those articles, there is many from education and promotion field area which the result regarding designs are highly positive feedback and success to attracted participants. The

article by Permana, F. et al. (2019) that used two type technology which is Augmented Reality and Leap Motion described outcome regarding limitation of the technology which is the appropriate distance, height, and brightness of the lamp. The results about the suitable characteristics are also described in an article from Tan et al. (2018) because they also use Augmented Reality technology. There is one article that described results based on testing and development (Pardue et al., 2011). After successfully debuted in front of over 5000 audiences, the instruments have been improved in terms of sensitivity and reliability and met musical goals of variable tunings, a wider sound palette, and easier transcription. Based on the authors of this one article (Oh et al., 2013), the results are from observing the development such as user can only play in the range of two octaves polyphonically because of separated construction for each mallet hitter. Another article that in the development phase (Putra et al., 2019) was easy to use and can connect to the server to play automatically. Maulindar et al. (2018) described the outcome where lots of improvement can be made although the project is success such as the prototype can only play one song with only one type of instrument from gamelan set.

Discussion

This review aims to investigate and analyze studies on the exploration of using technology as part of Asia's traditional musical instruments innovation. Almost all the articles state that the traditional musical instruments do not know by the public or almost extinct and changes need to be made to adapt the instrument in the modern world. Among the articles, three studies are used Augmented Reality technology (Phunsa, S., 2014; Permana et al., 2019; Tan et al., 2018) where some of the results described the technology has parameters that need to be emphasized to get better outcomes which is the distance, height, angle and light surrounding. This could affect the innovation that aims to easy to use. Permana et al. (2019) described that the simulation has a lagging problem which might be because of the use of large resource files or disrupted WiFi connection. The article that using Virtual Reality technology for Thailand traditional musical instruments (Trangansari et al., 2013) gives a positive outcome in the active learning system. However, the study does not describe in the article if there any limited number of audiences at one time entering the system and this was difficult to confirm whether the system reaches the goals as it is an online platform. Leng et al. (2018) and Ahmad Faris (2012) built a virtual application and state one of their aim is to preserve or revive the traditional instruments while according to Che Mat Jusoh (personal communication, October 13, 2020), the full changes of the traditional musical instruments' appearance are not recommended as it is important to maintain its originality. One article described Indonesia's traditional musical instrument (Pardue et al., 2011) which is the Balinese Gamelan. Although their replicated instruments are as good as the original because they still maintain the original shape using different materials, all the researchers are not the local people of the instrument origin. This is not a bad thing, and it gives rival motivation for local's researchers to build something that can preserve while introducing their local traditional musical instrument to the modern world. Two other articles that used replicated instruments are also completely not using original instruments (Wiradjaja, A., 2013; Oh et al., 2013) and they still maintain the appearance concept but with more light materials. Oh et al. (2013) does not discuss in the article the close distance between each infra-red sensor where it does not confirm the seemliness if an adult with a larger hand size than children try to play it. The other four articles are using the real instrument with a combination of different techniques which make it is easy to learn and teach but they do not open to various sample characteristics, and this could not confirm the effectiveness of learning those instruments

because only collect the data from a specific and small group of samples or does not have participants at all.

To gain the selected articles is not easy especially in this field area where the resources are quite limited and the use of different terms and language to describe the innovation of traditional musical instruments using technology. Sometimes there's an article found exactly as what wish for but has limited access or does not described the full research in the article. To obtain suitable literature, different terms should try to search by different synonym words or definitions. But of course, it is impossible to identify all the existing completed research.

Conclusion

The purpose of this article is to discuss the design and methodology, public acceptance of the technology used, and the future development where some of the studies already planned the improvement of their instruments. According to the review, the best methodology to use for this innovation is prototyping where if the progress still goes on, it has chances to add or remove something based on advice from the expert and qualitative method to collect end-user respond when the instrument ready to play.

Based on all the articles, no participant gives negative feedback thus prove that using such technologies can increase public interest toward traditional musical instruments. But it is found that the technological innovation of Asia's traditional musical instruments is still less studied and less published to be a reference which might affect its value level in this modern world with a lot of western music that more popular. More technological innovation on Asia's traditional musical instruments should do in the future to let it stay inline in this globalization era.

Future studies should try to focus on the less used concept and still promote the original traditions of the musical instruments which is the use of real instruments so that the modern world participants still can recognize the cultural heritage of the country. But it does not matter if some studies want to make the change with a better reason if there is still exists the original one that known in public. For that, if there any plan to change traditional musical instruments, it is supposed to ask review from the expertise in that field so that the tradition is not gone completely. Besides that, using the real sound coming from the instrument itself and without using any recording device is better to give the experience of the enchanting sound. To stay in line with modernization, it might include other sounds that produce by the audience to give a better experience.

References

- Ahmad Faris Ahmad Khairi. (2012). Virtual Gamelan Mobile Application. Retrieved from <http://utpedia.utp.edu.my/6263/1/1.pdf>.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International journal of social research methodology*, 8(1), 19-32.
- Damkliang, K., Thongnuan, A., & Chanlert, S. (2012). Traditional Thai Musical Instrument for Tablet Computer-Ranaad EK. *International Journal of Computer and Information Engineering*, 6(4), 505-510.
- Kapur, A. (2005). A history of robotic musical instruments. In *ICMC*. Retrieved from <https://www.semanticscholar.org/paper/A-History-of-robotic-Musical-Instruments-Kapur/fb6ca275674f67806e9f0796529e704305b098d7>.
- Leng, H. Y., Norowi, N. M., & Jantan, A. H. (2018). Virtual Kompang: Mapping In-Air Hand Gestures for Music Interaction Using Gestural Musical Controller. *Journal of Fundamental and Applied Sciences*, 10(2S), 24-34.
- Maulindar, J., & Librado, D. (2018). Prototype Alat Musik Tradisional Melalui Simulasi Bermain Saron. *Jurnal Informa*, 4(3), 20-25.
- Oh, C. G., & Park, J. (2013). The Kinetic Xylophone: An interactive musical instrument embedding motorized mallets. In *2013 IEEE RO-MAN* (pp. 292-293). IEEE.
- Pardue, L., Boch, A., Boch, M., Southworth, C., & Rigopulos, A. (2011). Gamelan ElektriKa: An Electronic Balinese Gamelan. In *NIME* (pp. 18-23).
- Permana, F., Tolle, H., Utamingrum, F., & Dermawi, R. (2019). Development of Augmented Reality (AR) Based Gamelan Simulation with Leap Motion Control. *International Journal of Interactive Mobile Technologies (iJIM)*, 13(12), 120-135.
- Phunsa, S. (2014). Applying Augmented Reality Technology to Promote Traditional Thai Folk Musical Instruments on Postcards. In *Proc. International Conference on Computer Graphics, Multimedia and Image Processing*.
- Putra, B. D. R., & Wibowo, A. P. W. (2019). Perancangan Kontrol Alat Musik Angklung Menggunakan Arduino, ESP8266 dan Android. *JOINT (Journal of Information Technology)*, 1(1), 11-14.
- Simeon, J. J. C. (2015). The U9 Xylophone: An Innovation in Music Classroom Teaching. *Wacana Seni Journal of Art Discourse*, 14.
- Tan, K. L., & Lim, C. K. (2018). Development of traditional musical instruments using augmented reality (AR) through mobile learning. In *AIP Conference Proceedings* (Vol. 2016, No. 1, p. 020140). AIP Publishing LLC.
- Trangansari, A., Chaisanit, S., Meeanan, L., & Hongthong, N. S. (2013). The Edutainment of Online Thai Traditional Musical 3D Virtual Reality Museum.

Wiguna, R. D. Y. (2019). Pengenalan Alat Musik Tradisional Indonesia Menggunakan Augmented Reality. *JATI (Jurnal Mahasiswa Teknik Informatika)*, 3(1), 396-402.

Zhang, Y., Liu, S., Tao, L., Yu, C., Shi, Y., & Xu, Y. (2015). ChinAR: Facilitating Chinese Guqin Learning Through Interactive Projected Augmentation. In *Proceedings of Third International Symposium of Chinese CHI* (pp. 23-31).