Exploring The Playability of "Air Bonang" in Malay Gamelan Ensemble

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ABSTRACT

This paper describes our reflections on an investigation of the playability of a Digital Musical Instrument (DMI) of a Malay gamelan *bonang,* where we explore its practicality, relevancy and reliability for ensemble music making. We present a project involving the Malay gamelan community, where they implemented the DMI named Air Bonang into their musical practices. Using the User-Centred Design (UCD) method, which focuses on the participation of potential users in the design and evaluation process, we engaged three gamelan groups to evaluate Air Bonang in their own musical environment. This exploratory study revealed that using Air Bonang that combines virtual and real-world aspects within the context of gamelan playing poses challenges to communication, presence, and social connectedness. We conclude that designing musical interfaces based on traditional musical instruments must prioritise the authenticity and identity of the musical culture while providing novel means of interaction to elevate musical performance.

Keywords: digital musical instrument, gamelan *bonang*, Malay gamelan, music interaction, virtual gamelan

INTRODUCTION

In the field of Human-Computer Interaction (HCI) and Interaction Design, developing technological interfaces typically involve potential users in the design, evaluation, and implementation stage (Sharp et al., 2019). This empowers them in making design decisions to create products or services that meet the needs of their expectations by applying their knowledge and experiences. Within the field of music interaction in HCI, designing musical interfaces involves potential users, typically musicians, composers, dancers, and specific communities. It is essential to understand the extent of the designs that can benefit the users so that they can be fully utilised and optimised within various musical contexts. This study employs the Research in the Wild (RITW), research methodology used by Rogers & Marshall, 2017), where development of new technologies for everyday life is designed and evaluated *in situ*. RITW studies' findings can be used to question assumptions about technology and human behaviour in the real world, as well as to inform the rethinking of HCI ideas.

Designing musical interfaces inspired by non-Western musical cultures have yet to be extensively investigated despite gaining popularity in recent years (Saffian et al., 2023). Intended to preserve, provide access, and spark the interest of these instruments to the younger generation, the designs of these musical interfaces are often simplified, providing merely alternatives to the actual musical instruments. The design and implementation often neglect the instruments' unique identities, authenticities, and cultural traditions (Saffian et al., 2022).

This paper describes our reflections on our empirical research in implementing a Digital Musical Instrument (DMI) of a Malay gamelan instrument into real-world musical settings. The integration of DMIs in traditional musical ensembles has yet to be extensively explored, investigated, and discussed, particularly in how practical, relevant, and reliable they are in providing new means of music-making while at the same time preserving the essence of its cultural traditions. This paper aims to come closer to understanding how a new musical interface fits into the different musical practices of the Malay gamelan communities in Malaysia. This study's results provided some considerations for improving the DMI further and how it can be implemented for musical activities.

This paper is structured as follows. Section 1 introduces the background of this paper. Section 2 presents our view on User Centred Design approaches in music interaction. Section 3 describes a project where we explore the implementation of the Malay *bonang* DMI in real-world settings, followed by the findings discussed in Section 4. In Section 5, we reflect on the project, highlight some challenges we faced, and conclude the paper.

USER-CENTRED DESIGN IN MUSIC INTERACTION

User Centred Design (UCD) describes the iterative design process in which designers prioritise the users and their needs in every stage of the design process to develop highly usable and accessible products for them (IxDF, 2016). In music interaction, which describes the relationship between music and HCI (Holland et al., 2019), UCD often involves a diverse set of users, including people with disability, composers, performers, audiences, and composers, among others. It

mainly focuses on the participation of potential users in designing and evaluating various types of musical interfaces that support musical creation activities specific to their needs and implementation. In inclusive music, for example, this process is described through the involvement of the end-users and stakeholders, such as caregivers, parents, and facilitators in designing inclusive musical instruments that are bespoke to specifically cater to the needs of users such as individuals with cerebral palsy (Lucas et al., 2019; Mccloskey et al., 2015). Design practices in inclusive music emphasise the strengths and abilities of individual users (Samuels & Schroeder, 2019); thus, it can also be extended to other users, such as in designing wearable musical interfaces (Cavdir & Wang, 2022; Turchet & Barthet, 2019). This paper is a part of a larger study, where we design and implement a Malay *bonang* DMI in musical settings. Our work involves the Malay gamelan community in Malaysia, where we engaged early on with several gamelan experts to understand the design requirements for developing a gamelan DMI (Saffian et al., 2022). We then proceeded with an evaluation in a lab-controlled setting before extending it to the current study presented in this paper. Details of this final study are explained in the following sections.

PLAYING THE MALAY *BONANG* DMI IN MUSICAL SETTINGS

To understand how the different Malay gamelan ensembles incorporate new technology into their own musical practices (Bryan-Kinns & Reed, 2023), we worked with three gamelan groups representing different backgrounds of the Malay gamelan community. They were divided into three categories based on their expertise and backgrounds: expert, amateur, and novice. The study adopted the "in the wild" research method (Lazar et al., 2017; Rogers & Marshall, 2017), where real users interact with emerging technologies in realistic environments under the conditions of actual use (Benford et al., 2013). In total, 36 participants were recruited for the study. Table 1 shows a summary of the participant's demographic information.

Table 1. Summary of demographic information of the gamelan groups.

Group	Expert	Amateur	Novice
Number of Participant	9 (6 male, 3 female)	11 (3 male, 8 female)	16 (8 male, 8 female)
Participants Profiles	Musicians Gamelan students Composers Arrangers Music Directors	Undergraduate and postgraduate students of various academic programmes	Undergraduate music students who play various musical instruments

We developed a DMI based on the gamelan *bonang* instrument named Air Bonang (Figure 1). The initial design process of Air Bonang involved participation from several gamelan experts, whose needs and requirements were elicited (Saffian et al., 2022).

Air Bonang is designed to provide users with the experience of playing the instrument in an immersive environment in a natural, expressive, and explorative way. The *bonang* instrument is represented by ten knobbed gongs that are struck using wooden mallets (Figure 2). Air Bonang simulates the *bonang* playing gesture in virtual reality using the Meta Quest 2 VR device. It has two gameplay modes, Traditional and Exploratory. The Traditional mode allows the user to play Air Bonang like the actual instrument. Meanwhile, the Exploratory mode presents a flexible virtual environment where users can move the individual *bonang* gong within the 3D virtual environment.
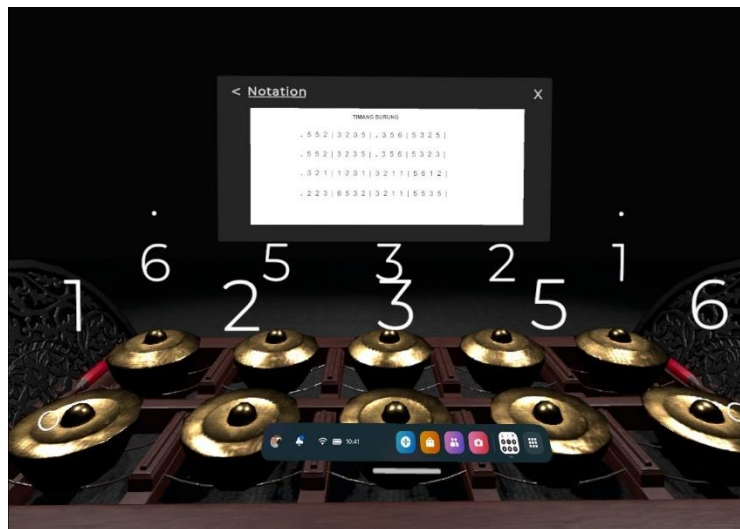

Figure 1. Air Bonang, a DMI based on the Malay gamelan *bonang* instrument.

Figure 2. The Malay *bonang*, also known as *keromong*.

We conducted a three-day workshop; each day is held for different gamelan groups. The workshops took place at their respective rehearsal space so that we could investigate the use of technology in familiar surroundings, where the group members have a common knowledge of their musical practices and use them as a scheme of

interpretation enabling coordinated action and the continuous conduct of social life (Nilsson et al., 2019) (Figure 3). No performance goals were established; rather, the group members decided what needed to be done in order to explore how Air Bonang is used in different situations using the Media and Arts Technology (MAT) *proof-of-concept* method (Bryan-Kinns & Reed, 2023). We instructed them to explore Air Bonang freely; they could choose any gamelan pieces to play, and in which gameplay mode. While one user used the VR device to play the Air Bonang, the other participants were encouraged to accompany the pieces played on the actual gamelan instruments. The participants' interaction with Air Bonang and one another was video recorded. At the end of the workshops, all participants were given an online questionnaire to complete. A focus group session was also held with the expert group to acquire more in-depth insights into their experience as gamelan experts. The data presented in the findings in the following section pertain to all three workshops.

Figure 3. Different venues where the workshops were held, experts (left), amateurs (middle), and novices (right).

FINDINGS
This study reveals insights into how the Malay gamelan community integrates new technology into their musical practices and to what extent it can be implemented in these musical settings.

Musical Practices of Malay Gamelan Ensembles
We observed how the different groups integrated Air Bonang into their gamelan ensembles from the workshops conducted. Despite being given the same instructions, all groups used Air Bonang differently based on their background, expertise, and musical practices. The observations we made on these different groups cannot be generalised to the entire Malay gamelan community; however, they provide insights into the different musical practices of the diverse groups.

The expert group was found to be using Air Bonang at its best potential. They played 13 different gamelan pieces of different styles as the members were skilled and knowledgeable on various gamelan repertoires. They were also seen at ease playing music impromptu or improvisation with Air Bonang and other gamelan instruments. Overall, there was clear communication within the ensemble throughout the study on different musical aspects of musical creation, such as determining the song selections, exploring various musical ideas (i.e., how to play), and executing musical directions (i.e., what and where to play). A video of the expert's interaction with Air Bonang can be viewed by clicking this link https://www.youtube.com/watch?v=y0mBpGWHmSw.

Meanwhile, the amateur group played six gamelan pieces in total. The group consists of nine student members and two instructors. The student members were observed to

be relying heavily on gamelan notations as they only played the pieces with the provided music scores in Air Bonang. The instructors were more adventurous and played two contemporary gamelan pieces. The group's instructors actively led the ensemble musically and dynamically throughout the session (Figure 4). Perhaps due to their status as students in the group, they were not as independent and communicative in determining their musical direction during the workshop. Instead, they relied solely on instructions given by the instructors.

Figure 4. Amateur group led by two instructors, where one is seen playing the gendang (male) and another playing Air Bonang (female).

The novice group was identified as beginners who are still learning to play the gamelan. Throughout the workshop, they relied heavily on music notations displayed on the venue's whiteboard from their previous lesson and the ones provided in Air Bonang. All the participants played the same gamelan piece throughout the session. They also took much longer to practice the piece before being ready to play with the accompaniment, reflecting their inconsistencies and hesitance. As the instructor was not present during the workshop, the musical direction of the ensemble was determined by the group's more senior members.

Playability Of Air Bonang in Diverse Musical Contexts

The Malay gamelan has evolved tremendously from its role as a court ensemble to now being performed at various events, reaching a much larger audience. This has impacted the musical repertoires from its inception till now. Traditional gamelan pieces are played with the *bonang* fundamental techniques in supporting the role of the instrument in the gamelan ensemble. However, more efforts have been made to create new Malay gamelan compositions that challenge musical traditions. Known as contemporary gamelan music, it fuses musical influences from other musical cultures, including playing techniques, melodic, harmonic, rhythmic patterns, instrumentation, and timbral manipulation, among others (Shah & Poheng, 2021).

For the workshops, the recruited gamelan groups played various gamelan music of different styles with Air Bonang. A total of 17 gamelan pieces were played during the workshops, combining traditional and contemporary pieces and improvisations. The participants used Air Bonang to play the *bonang* musical parts, while other gamelan instruments accompanied the pieces as they would within the ensemble (Refer to the video at https://www.youtube.com/shorts/5xBW8QaN7k4). Other gamelan instruments, namely *saron barung, saron peking, gendang, gambang, demung, kenong, gong suwukan*, and *gong agong* were used to accompany Air Bonang (Figure 5). Air Bonang could generally accommodate these different pieces, which had

different musical styles, techniques, and tempos. In the interview, the participants thought they could play the traditional repertoire well with Air Bonang. However, due to the system's responsiveness, they had to adjust the tempo when playing contemporary pieces. However, it did not significantly affect the way they played the pieces.

> "In a lot of the contemporary pieces that we played, the tempos were slowed down. So, if we want to play with the right tempo, the VR system cannot do that." (***E10***)
> "… as I played the contemporary pieces just now, I think the faster beat was okay because the latency is very low. It is as if I was playing the real *bonang*." (***E4***)

Figure 5: Malay gamelan instruments.

The participants highlighted the importance of adapting to playing the Air Bonang as the experience differs from the real instrument. The *bonang* is played by striking the gongs using a pair of wooden mallets. This gesture cannot be fully simulated with virtual reality as the virtual *bonang* is struck in mid-air instead. Striking in mid-air takes away the physical feedback that the participants found unsatisfying. However, this gesture could be compromised by optimizing the haptic feedback through the vibration of the hand controllers. Striking in mid-air also restricted some instrumental techniques that could be played on the actual *bonang*, such as the *glissando*, where the mallet glides upwards or downwards over two or more notes, as well as *tekap*, where the gong is lightly pressed after striking to mute the pitch from sustaining. The participants also commented on how they needed to get used to fully immersive virtual environments where their Field-of-View is limited from wearing the head-mounted display (HMD).

> "Of course, when I first tried it, I couldn't see all of the *bonang* gongs…but after repeating the melody several times, I already know their positions and was able to reach the gongs accurately." (***E2***)

Collaborative Dynamic in Gamelan Ensemble

The study requires Air Bonang to be played with gamelan instruments within an ensemble setting, combining two different environments: the real and virtual worlds (Figure 6). Several aspects of each group's collaborative dynamics were investigated, which include presence, social connectedness, performance setup, and explorability.

Figure 6. Air Bonang user accompanied by fellow gamelan members.

During the workshop, the participant playing Air Bonang had to wear the HMD, limiting his visuals within the virtual environment. As they could not see the rest of the ensemble, they needed to rely solely on auditory skills to accommodate their playing with the rest so that the desired musical output could be produced. Consequently, Air Bonang users felt isolated and lacking presence despite playing together with other members. 'Presence' or 'place illusion' (Slater, 2009) has been identified as a key element in virtual reality, including music interaction (Serafin et al., 2016; Turchet, 2023; Zellerbach & Roberts, 2022), with significant implications for musical performance. This was one of the challenges that affected the ensemble's musical collaboration dynamic.

> "Usually, when we're playing live with real instruments, the musicians would know if we're giving cues with our bodily gestures, for example, "We're going to go to the ending section now", so then the rest of the ensemble will take the cue and follow. I felt somewhat isolated when I was playing the contemporary piece just now. For the '*kotekan*' part, I would usually sit facing the other player. This way, I could see what he was playing to sync my parts with him and match his energy, whereas just now, I only had to rely on what I was hearing and tried to follow." (*E8*)

The study's setup also posed a challenge for the participants to communicate with one another in the usual way, both verbally and non-verbally. The lack of communication affected the social connection between the ensembles. Musicians tend to communicate non-verbally with one another when playing musical instruments collaboratively through gestural or eye contact (Laroche et al., 2022; Volpe et al., 2016), and this was also commonly practiced within the gamelan ensemble. Since the Air Bonang user could not see his fellow musicians, it was challenging to communicate effectively. The same difficulty was also felt by the supporting members playing the accompaniments. The disconnection between the two parties was felt, resulting in the

compromised quality of playing and musical output. Although the questionnaire ratings of the social connection aspect are generally rated rather positively (Table 2), the participants expressed otherwise.

Table 2. Ratings for 'social connection' with minimum, maximum, mean, and standard deviation.

	Min	Max	Mean	Std. Deviation
I feel virtually 'present' when playing the Air Bonang with the rest of the gamelan ensemble.	2	5	3.94	.919
I feel connected with the gamelan ensemble when playing the Air Bonang.	2	5	3.71	.938
Playing the Air Bonang with the gamelan ensemble made it more social and collaborative.	2	5	3.94	.851

Another aspect that the participants highlighted about collaborative playing is optimising performance setup. The merging of real and virtual worlds in a musical performance requires attention to specific technical requirements that vary from one occasion to another, such as practice, rehearsal, and stage performance. For the workshop, some of the small gamelan instruments (*peking, saron, demung, gender,* and *gendang*) were arranged in a semi-circle formation, behind the Air Bonang player while other heavier instruments (*gong agung, kempul,* and *kenong*) remained in their fixed positions at the studio. A play area for Meta Quest 2 was set up in the middle of the semi-circle, facing the front camera so that the user's interaction could be cast and recorded. This setup was the most optimum for the experiment, considering the space limitation in the gamelan studios. To ensure that the whole ensemble could hear the sound output of Air Bonang, a speaker was connected to the HMD using an audio jack facing the ensemble. Using the audio jack somewhat limits the participants' movement; however, they did not seem to mind it as no significant and sudden movements were made. They were more concerned about not being able to hear themselves clearly when playing Air Bonang with the other instruments.

Despite some challenges in implementing Air Bonang in these musical settings, the participants saw its future potential. Other than the musical contexts of the study, with some improvements, it could enhance and challenges the boundary of traditional gamelan playing. The participants perceived Air Bonang as not bounded by the traditional context of gamelan. It provides unconstraint gestural interaction so that they can explore new musical gestures for gamelan performances.

> "When I played in the Traditional mode, I felt like it came together with the '*adab*' or manners of the Malay gamelan etiquette. In my head, I knew that I had to apply the *serentak, bergilir* techniques and whatnot. So, the environment feels like when we play the traditional piece or arrangement. In the Exploratory mode, I felt freer to play as it can be anything, any notes, any song, or whatever." (***P4***)

Another potential of Air Bonang includes collaborative use, where several users can play it remotely. As the gamelan is played as an ensemble rather than individual

instruments, this could be further explored in the immersive environment of virtual reality. The positive ratings for the creativity and explorabiltiy aspects of Air Bonang show its potential as an innovative tool in elevating the Malay gamelan performance to the next level (Table 3).

Table 3. Ratings for 'creativity' and 'explorability' with minimum, maximum, mean, and standard deviation.

Creativity	Min	Max	Mean	Std. Deviation
Playing the Air Bonang allows me to be creative.	2	5	4.12	.844
I feel that the Air Bonang can support me in creating new music.	2	5	4.18	.904
Air Bonang offers new possibilities to express myself musically.	2	5	4.00	.853
Explorability	**Min**	**Max**	**Mean**	**Std. Deviation**
I can continuously discover new things by using the Air Bonang.	2	5	4.00	.985
The Air Bonang offer me new ways of playing the *bonang*.	2	5	4.24	.923
I can imagine playing the Air Bonang in different musical contexts.	2	5	4.06	.851
The Air Bonang expands my experience of musical interaction.	2	5	4.06	.919

CONCLUSION

We have presented a study where the users explored playing a virtual reality gamelan instrument in their ensembles. The participants demonstrated their use of Air Bonang within the practices of their musical ensembles based on their knowledge, expertise, and practices. This study's findings enlightened us on important aspects of designing and implementing a DMI based on the Malay gamelan instrument. Although technology is seen as a way forward in preserving traditional musical cultures, we must also consider how it is implemented in realistic settings. From this study, we learned that although the Malay gamelan communities were open to the idea of a virtual gamelan and its flexibility, it must not take away the instrument's identity and should be complementary to its musical traditions. Playing the Malay gamelan is not just an act of producing musical performances; however, it also comes with specific traditions and etiquette deeply rooted in its early beginnings as a court ensemble. Hence, this aspect must not be neglected in designing and implementing new musical interfaces inspired by the Malay gamelan, as it is equally crucial for the sustainability of its musical cultures.

Playing in a musical ensemble requires synchronicity, unity, and clarity in musical direction to produce a cohesive musical performance. Combining the virtual and physical environments within the context of gamelan playing poses challenges to communication, presence, and social connectedness. There must be practical solutions to address these challenges, such as optimising the performance setup so that the ensemble can see, hear, and communicate with one another to create music instantly and cohesively without a barrier. Recent upgrades on VR devices have incorporated mixed reality experiences where both the real and virtual worlds are presented in a single display, which may be implemented in our future works.

We also reflected on some of the design processes implemented in the study. This study adapted the Media and Arts Technology (MAT) *proof-of-concept* method to see how users respond to newly developed creative technologies (Bryan-Kinns & Reed, 2023). However, the limitations identified in this study might not fit into this method, which highlights early-stage investigations of how people react to new forms of interaction rather than at the evaluation stage of the technology as presented in this study.

As we were constrained by time and financial resources, we could only conduct one workshop session for each gamelan group. The one-off session may not allow the participants to explore and experiment with the Air Bonang to its fullest potential. Successfully performing a musical piece in an ensemble requires sufficient practice over time. The lack of practice had probably hindered the amateurs and the novice groups from performing successfully, as there was not enough time for them to master the musical pieces prior to playing with Air Bonang, where this is one aspect that we wish to improve.

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