GAMELAN MELAYU SOUND PRESERVATION AND ARCHIVING THROUGH RECORDING METHODS AND PRODUCTION TECHNIQUES

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Abstract

Sound or audio engineering is a branch of the field of engineering, which involves the process of recording sound and reproducing it by various means, as well as storing in order to be reproduced later. Known as sound or audio engineers, these trained professionals work in a variety of sound production fields and expert in recording methods. They can be instrumental to implement the affordable technologies and technical process to distribute the audio data hence, making it accessible for future generations. The current role of these engineers not only to perform or limited to recording session but they create metadata for archiving and preservation for future needs. Currently, product sleeves of ethnographic recordings represent no technical elements of how traditional music recordings are produced. The product details focus only to some extent on historical elements and musical notation. To an audio archivist, declaring what devices are in a recording is not linked with preservation data. Apart from the format, the sleeved design, technical specification is essential to other social scientists such as audio engineer and field recordist of the future. The aim of the present research is to capture optimum dynamic range of the sound and applying a signal processing that would not alter the tonality, timbre and harmonic of the sound. Further applying a suitable information storage for the metadata to be preserve or archived for future accessing and reproduction.

Keywords: Sound engineering, Recording methods, Gamelan Melayu, Metadata, Preservation

MICROPHONES TYPES, PATTERNS, AND TECHNIQUES

The most common microphone types used in audio production is dynamic[1], condenser[2] and ribbon[3]. Microphones are also, categorized according to how well they pick up sound from certain directions. Omni-directional detect sound equally well from all angles, bi-directional pickup from the front and back but not the sides, and uni-directional only pick up sound from the front. The directionality or the polar pattern indicates how sensitive it is to sounds arriving at different angles about its central axis. The polar patterns represent the locus of the points producing the same signal level output in the microphone if a given Sound Pressure Level (SPL)[4] is generated from that point. How the physical body of the microphone is oriented relative to the diagrams depends on the design of the respected microphone. All microphones have a distinctive sound character is based on its specification and large number of types, models can be used for variety of applications, and the engineers can choose the right ones to

[1] Dynamic: Microphones have a coil connected to a diaphragm that moves between a fixed permanent magnet. Vibration causes the diaphragm and coil to move, inducing a current in the coil proportional to the vibration.

[2] Condenser: Microphones are a capacitor with a fixed plate and a moving plate connected to a diaphragm. Air vibrations cause the diaphragm plate to move slightly and change the voltage between the plates.

[3] Ribbon: Microphones use the movement of a thin metal foil suspended in a magnetic field to create a signal.

[4] Sound Pressure Level (SPL): Is the acoustical pressure that is built up within a defined atmospheric area, i.e. threshold of hearing. Logarithmic measure of a sound relative to a reference value.

serve the purpose. We can use what is available for the recordings at given time or acquiring additional microphones to suit the recordings (Huber & Runstein, 2010: 132). We can break up microphone techniques to following microphones placement, distant miking[5], close miking[6], accent miking[7] and ambient miking[8]. This placement is directly, related to the working distance of a microphone from its sound source.

POPULAR MUSIC TECHNIQUE ADAPTION IN GAMELAN MELAYU

Technical methods of '*popular music'* have been adapted into traditional music ensembles in Malaysia for recording thus creating imitative in originality of sound. The most common practise is the close miking technique with single microphone, with the aim of sound is can be heard. This technique will work if it is mono-aural sound for example like snare drum which have high-density loudness, in terms of the gamelan sound, the spatial stereo could not be established and a listener would not be able to feel the panoramic of the sound. For example, figure 1, where single mic technique was used for Keromong without a proper signal source aim in national Gamelan Melayu competition in year 2013, held in Kuala Terengganu. On the other hand, figure 2, shows the use of omni dynamic microphone with un-recognised mic pattern which resemble similar to AB but in different angle of aim to the sound source.

Figure 1: Use of a single miking technique for Keromong (Source: National Gamelan Melayu Competition year 2013 video, courtesy: Photography Department, Terengganu State Museum).
Figure 2: Two omni dynamic microphones on Gambang with un-recognised mic technique (Source: World Gamelan Festival year 2015 video, courtesy: Photography Department, Terengganu State Museum).

According to a definition provided by Eargle (1996: 384), popular music embraces a wide variety of styles, and recording approaches extending from simple stereo miking to multi complex microphone line arrays in the large recording studio for orchestras and rock groups. Common practise in pop recording is the general reliance on the taste of the engineer and the producer in creating a sonic texture quite apart (different) from that what may exist naturally. The recordings engineers hold the creation of a stereo stage, rather than importance of the simple recreation of an acoustical stereo stage. The meaning of this term could be put as the manipulation of the sound during the recordings or during the mixing stage could create adulterate version of the natural sound source. Lewis (2011) said that microphone practice is instrumental in creating the characteristic sound of a track. Selecting a dynamic or a condenser microphone influences the resulting sound of a recording, as the both mics have different frequency response of the soundwaves.

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5 Distant miking: Positioned at a distance of 3 feet or further away from the intended signal source.
6 Close Miking: Positioned at a distance of 1 to 3 feet from the intended signal source.
7 Accent miking: A mic added for volume and especially for presence.
8 Ambient miking: To pick up the reverberant or room sound equally or more prominent than the direct signal.

Another adaption from the popular music style is multitrack recordings, where by every instrument is recorded individually for better acoustics isolation but losing the sonic characteristics. The technique is to record one instrument per time, till all instruments is recorded and combining them in mixing process. With properly positioned microphone use, classical music recordings often mixed live and recorded to final master, on the other hand, pop music is rarely recorded live rather created in the recording studio. They are recorded on to multitrack medium, often a few tracks at time and gradually build the montage of the sound. Upon completion of the recordings, in the mixdown process, further post-production takes place such signal and dynamic processing (Rumsey & McCormick 2014: 169 – 170). Classical and popular music have their own definitions of 'good sound'; classical music (folk music) aim is to accurately reproduce the live performance, the recording engineer with respect to the music, he or she should translate that sound with little technical intrusion as possible. Meanwhile popular music aim is to sound better with more clear, less harsh, tighter, creating own standards of quality differentiating from accurate reproductions (Bartlett & Bartlett, 2009: 331 - 332). They pointed out that the recording realism or the accurate reproduction is successful when the recording matches the live performance.

RECORDING PROCESS

Early descriptions referring to sound examples of the Gamelan Melayu were provided by Sir Frank Swettenham who observed in the court of Pahang (1878: 165-166). Accordingly, he notes that two chief performers play a resemblance of a wooden piano knocking the notes with a piece of stick held in each hand. With a similar piece of wood, they played the bottom of metal bowls. Another performer played a gigantic gong with a very large and thick stick. Another player beats a drum with two sticks and others played on instruments that look like triangles. Since there were no physical recordings of this performance back then, but the written descriptions explain how these orchestra of the instruments look and played. Until 1967, the first physically recorded sound was in Istana Kolam Air, using Nagra III tape recorder, using ambient miking technique, following time change, later recordings were done as multitrack recordings and moving forward as digital recordings. Mubin Sheppard explains Radio Malaysia did the 1967 recordings. In figure 3 a microphone is positioned in a distant (ambient miking) to capture the Saron sound.

According to ethnomusicology (Hood 1971), the preparation of recording equipment's is essential in field recordings. From the tape recorders capability to mono recording or a stereo perspective and given the choice if the availability of multi-track recorders for better separation of sound recording and analysis. The choices of microphones likely dynamic cardioid are crucial for better response and capture of sound and miking distance as well as the angles. The microphones should be rugged and least affected by extreme temperature and humidity. Dynamic level of each microphones must consider all these factors. A proper playback monitoring is additionally important for listening the recordings for assessment. He suggests further, systematic entries (metadata) should be included both in recording and in photography inside the documentation log. There should acoustical environment, sketches (pictures) showing the arrangements of the ensemble being recorded, dynamic levels, carrying power (CP) [9] of instruments, microphone positioning, types of equipment and supplies used. Supplementary photographs (included video in current time) can document the physical aspects of the session.

[9] Carrying Power (CP): An electric circuit transfers electrical energy.

The recording recommendation follows the IASA-TC-04 (2009: 83 - 89) referring to audio file format[10], sampling rate[11], and bit resolution[12]. Stereo microphone techniques ORTF[13], XY[14],

Figure 3: Istana Kolam Recording by Radio Malaysia, we could see a gooseneck dynamic microphone placement in distant (ambient miking) to capture the *Saron* sound while played (Source: NST Annual 1984, open source).

AB[15] and MS[16] are used for capturing instrument signals. This recommendation includes the method how to carry forward the data for transfers, target formats and systems. A member of the Audio Engineering Society (AES), Bruce Bartlett[17] mentions that the engineer's job is to capture the performance on tape (storage medium / data) and to bring it back live (playback). Therefore, the researcher uses additional techniques and tips, which cover equipment and

[10] Audio File Format: File format for storing digital audio data on a computer system (WAV, BWF, AIFF).

[11] Sampling Rate: The frequency or rate, at which the analogue signal is sampled, usually expressed in hertz.

[12] Bit Resolution: An abbreviation for a binary digit.

[13] ORTF: Office de Radiodiffussion-Television Francaise. A stereo microphones technique using two cardioid pattern mics with their diaphragms are 17cm apart with an angle of 110°. Also known as Near Coincident Pair.

[14] XY: A stereo microphone technique using two mics on the same vertical axis at close proximity to each other with a 90° to 135° angle between them. It is also known as Coincident Pair.

[15] AB: A stereo microphone technique using two omni microphones whose axes are at 90°to each other. Mostly aimed at the left and right of the sound source.

[16] MS: A coincident microphone technique, in which the M (middle) microphone is cardioid, pointing toward the middle of the orchestra (ensemble), and the S (side) microphone is a Figure-8 (bi-directional), with its dead sides on the same axis as the front of the cardioid.

[17] Bruce Bartlett: A renowned microphone designer and recording engineer. A member of AES, written 8 books and hundreds of articles on audio topics.

procedures as demonstrated and discussed by him. Such as equipment's setup, selecting a venue, session setup, microphone placement, setting levels and editing (mixing & mastering) are essential procedures to be followed on on-location recordings (Bartlett & Bartlett, 2009: 439 - 455).

The gain[18] level of every microphone input to the mixer / interface must be taken into account whereby the levelling should orientate on the wanted signal not continuous adjustment of the level recording during recording. If the gain turned up full, it may cause overload the mic preamp, which again causes distortion and peaks. The proper way will be, adjusting the signal gain to reach peak 0dB and dropping between the range of -6dB for creating extra headroom. No pre-dynamic or signal processing should be applied in the recordings, which could change the tonality[19], timbre[20] and harmonics[21] of the recorded sound.

MICROPHONE TECHNIQUE FOR THE INSTRUMENTS

For the research, four type of stereo microphone technique was used: XY, MS, AB and ORTF in order to mike up the instrument particularly Saron Kecil, Saron Besar, Gambang, Keromong and Kenong. Stereo microphone technique methods capture a sonic event as whole, the miking preserves depth, perspective and hall ambience. Close-up pan-potted miking will loss the characteristics, with a good stereo recording, we can sense of an ensemble of musicians playing together in a shared space. Furthermore, it preserves the ensemble balance as intended, more likely to reproduce the balance as the audience hears it, left to right. The overall objective is the accurate localization that reproduced instruments should appear in the same relative locations as in live performance (Bartlett, 1991: 14 -18). A test sound sample recorded to analyse the wave dynamics range and response of the microphone. A pair of Samson CO2 condenser cardioid microphone was used to test all the instruments with the aim to create a standardise recording. The signal was recorded as stereo wave file at 48kHz sample rate 24Bit. Using the wave diagram in the recording software timeline, the microphones pattern selected for the best response and dynamic range that can produce by the particular pattern. Each sound and pattern were recorded three times for better evaluation, signal sustained and wave dynamic range, please refer to figure 4 for reference. Close mike up was used for gong and gendang as the instruments has surface area on each opposite side and has more narrow frequency range. Stereo microphone patterns for these instruments would not be suitable to capture the signal due to design of the instruments, instead close mike ups were used.

[18] Gain: The extent to which an active device (amplifier) is able to increase the amplitude of a given signal; the ratio of input to the output level.

[19] Tonality: character of the music relates to its key centre.

[20] Timbre: quality of the sound from acoustical value.

[21] Harmonics: naturally occurring fundamental frequencies or overtones.

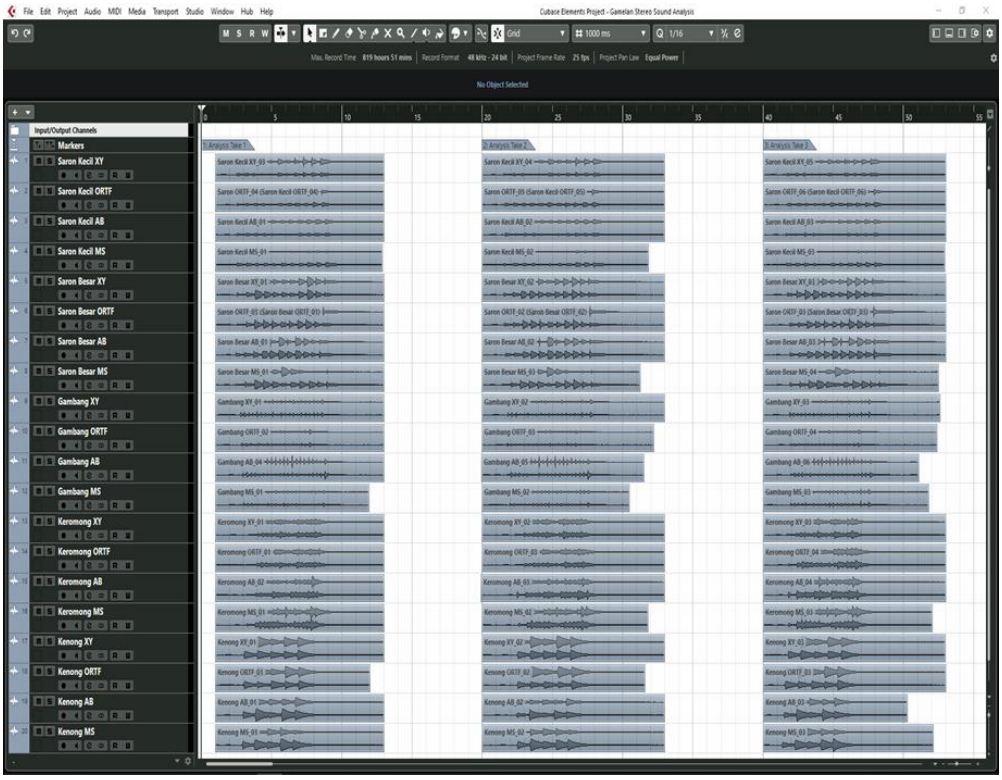


Figure 4: Stereo microphone pattern correspondent (Photo by the author).

RECORDING SPECIFICATIONS AND EQUIPMENT

Specification	Hardware / Software / Format	Note
Mixer / Interface	Behringer X32 Digital Mixer	Minimum 16-Channel Audio Interface or Mixer.
Workstation	Lenovo Legion i7, 16GB RAM, Windows 10, 64Bit System	Minimum hardware requirements for Operating System and DAW.
Digital Audio Workstation (DAW)	Cubase Elements 10.40	Any DAW with multitrack recording.
Monitor Speaker	Genelac 8040B	Monitor with a range of frequency spectrum playback.
Headphone	Audio Technica ATH M30x	Solo listening and in-hear.
Audio Format	Wave	PCM, Un-compress format.
Sampling Rate	48kHz	Minimum 48kHz, recommended 96kHZ.
Bit Resolution	24	Higher dynamic range and lower noise floor.
Storage	Internal WD 1TB HDD	Minimum hardware requirements for Operating System and DAW files.

Figure 5: Specification and equipment's use for this recording findings and minimum recommendation (scheme by the author).

The mixer accepts mic-level signals (instruments or vocal) and amplifies them up to line level (as separate tracks). From there the workstation receive the signal via USB connection. These individual signals are assigned according to the channels and record in the DAW Cubase as

multitrack simultaneously recording to the hard disk. Stereo[22] (Stereophonic) and mono[23] (monophonic) configuration used to setup the channel inputs according to the microphone technique that was applied.

ACOUSTICS

The recording took place in the rehearsal room of Music House 4 (figure 6), the Music Department the Faculty of Human Ecology, UPM. The enlarged rehearsal room (formerly a living hall) is part of single storey bungalow in a private plot. The room has a squared shaped with 29' x 22' length and width with brick walls on all sides. Dripped curtains (reduce vibration and dampen the sound). The flooring is concrete / tiles with thick layer of carpet (sound absorbers). The false ceiling (treated soft wood) height is 11' from the floor (block, reflect and reduce). The room has high window at top surrounded and normal windows, which are tight shut and layer by the curtains. The environment is like a semi-enclosed stage, where natural ambience and adequate reverberation still occur. A similar layout of the hall can be bigger or found in most of performing centres that resembles the private reception hall (balai) in Istana, which could accommodate more people.

For example, Sir Frank Swettenham describes the size of the hall and the building material (acoustic) in the Pahang Court as follows: The front of the house was a very large hall, open on three sides, but covered by lofty roof of fantastic design supported on pillars. Three wide steps continued around the three open sides, the fourth closed by a wooden wall, which entirely shut off the private apartments save for one central door over which hung a heavy curtain, approached the floor of this hall. The three steps were meant to provide sitting accommodation according to their rank for those admitted to the *astana.* A large carpet covered the centre of the floor, on the night in question, chairs were provided for us, and the rest of the guests sat on the steps of the dais (Swettenham, 1895: 46). It is almost certain that a gamelan performance requires space for the layout to be set up. A natural ambience guarantees a natural hearing. The recording technique used in these recordings can as well be applied at any soundproof living rooms that provides adequate space. A confined space will hamper the output of the respected ensemble performance.

In concert halls, the acoustic setting is vital in order to convey the music from the stage to the entire hall (both front and end seats), since it is obvious that the energy of music sound deteriorates upon reaching a distance. The more direct the sound can be perceived from the performance, the earlier the sound is reaching the ears and finally the reverberation occurring after the surface contact are felt. The balance between these three sounds will give the listeners a full panoramic (spatial) experience of the performed music (Robert, 1997: 46-51). The combination of accent, close and ambient miking for the ensemble was planned and executed to capture the performance of the gamelan from the acoustic importance to deliver the spatial experience to the listeners or the audience.

[22] Stereo: Stereophonic (commonly referred as stereo) refers to any sound reproduction method in which an attempt is made to create an illusion of directionality and audible perspective. This is usually, achieved by using two or more independent audio channels through a configuration of two or more channels in such a way as to create the impression of sound perceived from various directions, as in natural hearing. Multiple recorded sounds are combined into one or more channels, most commonly two-channel stereo.

[23] Mono: Monaural or monophonic sound reproduction (often shortened to mono) is a single-channel. Monaural sound has been replaced by stereo sound in most entertainment applications. However, it remains standard in radio and telephone communications.

Figure 6: Rehearsal Room of Music House 4, University Putra Malaysia, Malaysia (photo by the author).

RECORDING A GAMELAN MELAYU

The instruments of the Gamelan Melayu were arranged in the room according to the players discretion, a typical performance setup as demonstrated in figures 7 and 8. The microphone of each instrument was taken appropriate gain signal levels for the mixer and receiving DAW. The microphone technique and polar pattern setup for the instrument's recording session was clarified in figure 11.

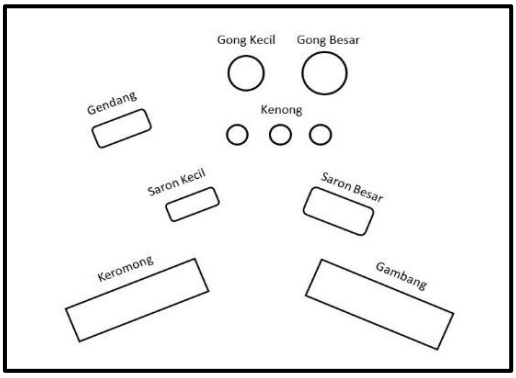


Figure 7: (left) Top view of the instrument's layout for recording (scheme by the author).
Figure 8: (right) The gamelan instruments and microphone setup for recording (photo by the author).

The following is the description of the recording session with equipment setups and the capturing of the signal to the DAW. The Behringer X 32 mixer, while keeping the fader of the receiving channel at 0db receives the individual sound signal (16 channels) from microphone. The gain pot of each channel is turned up from infinity to an optimum level before the signal peak at 0dB in the fader meter. The signal level entering the channel path is controlled by the gain pot. The linear fader controls the signal level leaving the channel path. By keeping the gain at this point, we can determine the maximum volume before peak and have drop constant average of -5dB to -6dB before peak and headroom (this procedure is done only once) in the fader meter. For all stereo inputs, the channel is panned hard Left and Right and all mono inputs, the pan is set at the centre. No signal or dynamic processing were added or compromised. A pair of monitor speakers was setup from the mixer for listening, and, playback and headphone for in ear critical listening. The internal interface of Behringer X32 converts the signals as digital and routes them out via the Universal Serial Bus (USB 2.0). The workstation receives the signal through the USB inputs and correspond to the recording Cubase DAW. The user assigns the incoming signals accordingly to the Cubase DAW channel inputs, name and enable

them for recording. For the playback corresponding channels, a basic balancing of the sound was adjusted for listening. Upon the completion of the recording, each session is internally, saved and transported to the backup hard drive. These steps are applied for the entire gamelan song repertoire recording except for the Timang Burung repertoire, the only vocal recording that was dubbed for the sake of a better isolation from the instruments. Figures 9 and 10 demonstrate the recording process in the flow.

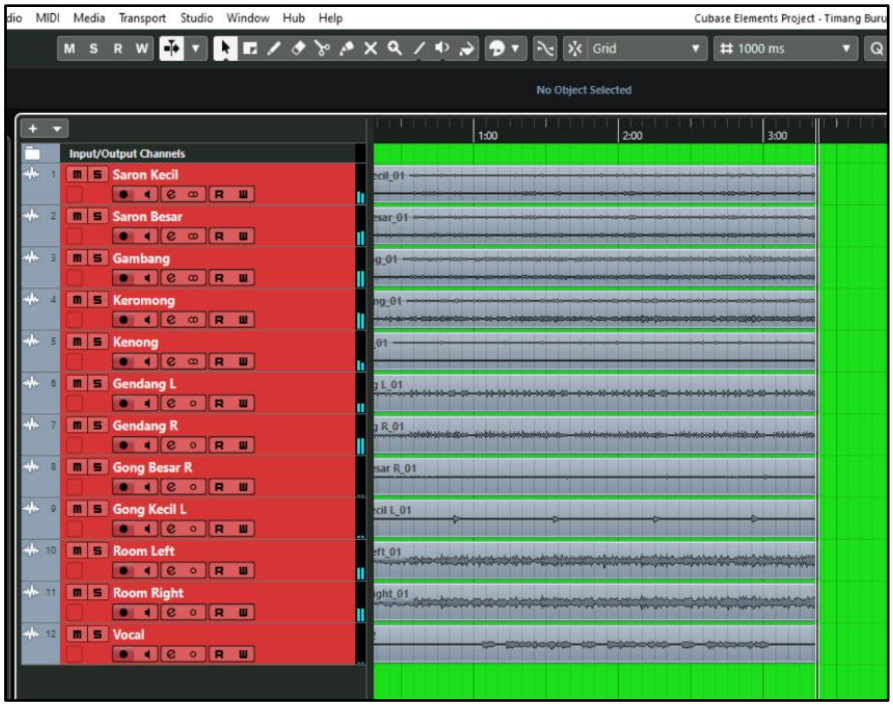


Figure 9: Cubase recording session for Timang Burung (photo by the author).

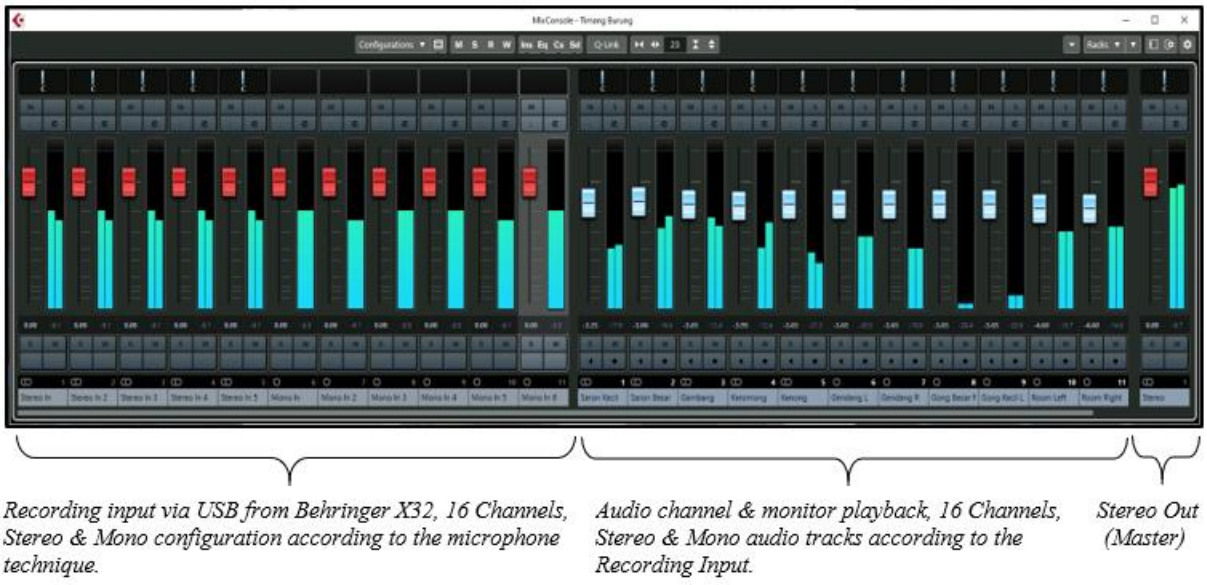


Figure 10: Cubase recording console, audio track and monitor playback for Timang Burung (photo by the author).

No.	Instru--ment	Mic Technique	Mic Polar	Mic Model	Distance / Note	Picture
01	Saron Kecil	ORTF, Accent Miking	Cardioid	2 unit of Samson CO2, Condenser	Position above, 10” height (approximately for optimum signal level). Mounted on a pair of mic stands. Wave signal recorded as Stereo.	
02	Saron Besar	XY, Accent Miking	Cardioid	2 unit of AKG C1000, Condenser	Position above, 10” height (approximately for optimum signal level). Mounted on a pair of mic stands. Wave signal recorded as Stereo.	
03	Gambang	XY, Accent Miking	Cardioid	2 unit of Apex 185B, Condenser	Position above, 10” height (approximately for optimum signal level). Mounted on a pair of mic stands. Wave signal recorded as Stereo.	
04	Keromong	MS, Accent Miking	Bidirectional, Cardioid	1 unit of AKG C414 B-ULS, Condenser, 1 unit of Antelope Verge, Condenser	Position above, 10” height (approximately for optimum signal level). Mounted on a pair of mic stands. Wave signal recorded as Stereo.	
05	Kenong	XY, Accent Miking	Cardioid	2 unit of Shure SM57, Dynamic	Position above, 1’ height (approximately for optimum signal level). Mounted on a pair of mic stands. Wave signal recorded as Stereo.	
06	Gendang	Close Miking	Hypercardioid	2 unit of Audio Technica ATM25, Dynamic	Approximately 3” from the hit point. Mounted on a single mic stands on both opposite sides. Wave signal recorded as separate mono for both sides.	
07	Gong Kecil	Close Miking	Omni	1 unit of AKG D112, Dynamic	Back portion, approximately 5” off axis from the centre point. Mounted on a single mic stands on both opposite sides. Wave signal recorded as single mono.	

08	Gong Besar	Close Miking	Omni	1 unit of Samson Q Kick, Dynamic	Back portion, approximately 5” off axis from the centre point. Mounted on a single mic stands on both opposite sides. Wave signal recorded as single mono.	
09	Vocal	Close Miking	Cardioid	1 unit of Rode NT-2, Condenser	Approximately 2” from the mouth. Mounted on a single mic stands with pop filter. Wave signal recorded as single mono.	
10	Ambient	AB, Distant Miking	Cardioid	2 unit of Rode NT-2, Condenser	Facing the gamelan, left & right of the assemble approximately 15’ apart, 3’ distance from the assemble, 8’ height. Mounted on a single mic stands on both opposite sides. Wave signal recorded as separate mono.	

Figure 11: Instrument Miking Details (Scheme by the author).

MIXING PROCESS

Audio mixing is a process, in which multiple recorded sounds are combined into one or more channels, most commonly two-channel stereo. In the process, the source signals' level, frequency content, dynamics and the panoramic position are commonly being manipulated and effects such as reverb might be added. The process takes place in the control room of a studio, which acoustically treated for neutral listening. This practical, aesthetic, or otherwise creative treatment is advisable in order to produce a mix that is more appealing to listeners. The mixing stage often follows multitrack recording and the final mixes are normally, submitted to a mastering engineer. Live sound-mixing and location-recording is the art of combining and processing several audio signals. This method allows creating a "mix" that the audience or performers at a live show hear. There can be a variety of different mixes required, depending on the performance requirements. The mix engineer commonly works with mono and stereo wave files recorded in studio or a location recording.

After all tracks are recorded (maybe with some bouncing), it is time to mix or combine them to a 2-track stereo. You may use the mixer fader to control the relative volumes of the instruments, use panning to set their stereo position, use EQ to adjust their tone quality, and use the aux knobs to control effects (Bartlett & Bartlett, 2009: 266).

It is suggested that sound mixing engineers involved in audio mixing of music are akin to be part of the performance of the song as well. It is not only confined to the hardware or sonic refinement of the studio, for example, the equalisation and compression, it involves the creativity of the engineer. Engineers are expected to train themselves to mix as performer to bring out more of the song artistic. Like the musician who perform in the song, the mixer - mixing as a performance increases the personalised approach towards the mixing process thus create a more connection or close senses to the song (Brendan, 2017).

Zagorski (2014) observed that final musical recordings could be rhetorically, divided into two perspectives, what is intended by the musician or the mixing engineer and by the perception of the audience. As the music cannot be analysed in a single way but it can through perception and recipients of the intended audience. The music can be influenced by structural place of recording, music engineering, cultural and geography, result to the output of the music recording. Zagorski suggests an analytic study on the process of music making on this model could close the theoretical gap between a creator's intentions and an audience's interpretations.

MIXING PROCESS SPECIFICATION AND EQUIPMENT

Specification	Hardware / Software / Format	Note
Interface	Antelope Audio Discrete 8	Minimum 2-Channel Audio Interface or Mixer.
Workstation	PC Intel i7, 32GB RAM, Windows 10 Pro, 64Bit	Minimum hardware requirements for Operating System and DAW.
Digital Audio Workstation (DAW)	Cubase Pro 10.40	Any DAW with multitrack mixing.
Monitor Speaker	Genelac 8040B	Monitor with a range of frequency spectrum playback.
Headphone	Audio Technica ATH M30x	Solo listening and in-hear.
Audio Format	Wave, Stereo and Mono Configuration	PCM, Un-compress format.
Sampling Rate	48kHz	Use recording sample rate.
Bit Resolution	24	Higher dynamic range and lower noise floor.
Storage	Internal WD 500GB HDD	Minimum hardware requirements for Operating System and DAW files.

Figure 12: Specification and equipment's use for this mixing findings and minimum recommendation (Scheme by the author).

Looking at the table in figure 12, hereby the specifications and equipment's that were used for the mixing process in the studio. This equipment can be replaced with its equivalent or with specifications that could handle multitrack wave files. The recorded wave file format should not be downgraded, to protect the quality of the digital audio that remains intact and unchanged. Regardless of how many times we process or re-encode, the wave files will have same quality.

MIXING A GAMELAN MELAYU

The initial step of the mix was setting the mixers faders to 0db (zero) for all the instruments tracks and keeping the channel faders in mute with monitor volume at desirable listening level. For the next step, the channel faders were unmuted one by one then the faders were brought to the desirable listening levels, this is followed by all instruments channel faders. No signal and dynamic processing's were applied to the wave files to ensure the natural state of the sound recorded. This follows the recommendation of IASA TC-04 Sub-topic 5.7.4 approach to recording as well as the ethnomusicologist suggestion (Hood 1971: 261), namely sound signals from all mics that go to the tape (DAW) in order to balance the signals properly. This application allows the composite to give the best simulation of the live sounds. The mix changes

only consist of channel volume (fader levels) and panning (LCR[24] position of the audio sound, stereo imaging). In this research, the Gamelan Melayu recordings were mixed according to the playing structure as well as the intensity and from audience or listeners perspective facing the gamelan assemble. The Kenong and Gong are colotomic instruments, which act as the musical phrase, the channel volume, is setup as a base for the mixing. The Gendang as the time (tempo) keeper, channel volume slightly lower from the colotomic instruments (varies on type of playing density). The Keromong and Gambang elaborate the main melody, whereas the channel volume is above of the colotomic instruments and the Gendang. The Saron Kecil and Saron Besar support the main melody. Regarding the vocal part, channel faders were set above all instruments for the sake of clarity and both ambient mike as support for the entire ensemble. The Kenong is recorded following the ORTF technique in stereo input and the tracking track. The volume is set as base for the repertoire. The channel pan is set as full left right for the stereo image. Gong Besar and Kecil were recorded as close miking in individual mono input and the tracking tracks. The channel pan for both was set as centre hence, allowing the low frequency of the gongs has more reproduction in terms of density. Gendang the only membranophone, were recorded as close miking in individual mono input at both surface and the tracking tracks, the channel pan for both was set as Left half and Right half allowing the low and mid frequency of the gendang has separation from the gongs, also to imitate the movement of the gendang player hand when striking it. The Keromong were recorded as MS technique in stereo input, in the tracking track, the stereo file was split, keeping middle cardioid input pan at centre, the bidirectional (Figure 8) were duplicated to create Left and Right individual mono with the duplicated channel out of phase to avoid phase cancellation. In the mix, the researcher has three-channel volume of the Keromong to create the panoramic playback of the instrument. This is followed by the Gambang, which were recorded as XY technique in stereo input and the tracking track, the channel pan was set as full left right for the stereo image. Saron Kecil and Besar recorded in ORTF and XY technique in stereo input and the tracking track, both channel pans were set as full left right for the stereo image. The ambient mics (room mics) recorded in AB technique in mono input, the tracking track for better separation, the channel pan for both was set as full Left, and Right allowing the characteristics of the environment can be perceived as panoramic movement of the entire ensemble. The only vocal recording was in mono input and the tracking track, the channel pan was set at centre for clarity and space for the voice in middle to cut through the other instrument to be heard. These steps were used for all the following repertoire to create the final mix, as one objective for preservation is to keep the natural sound, the final mix were not mastered but aimed to achieve a maximum output below 0dB peak. Following figure 13 shows the Timang Burung repertoire mixing process in timeline of Cubase DAW. In the figure we could note stereo and mono files configuration, MS techniques configuration for the mixing and editing of muting empty part of the vocals from the dubbing recording. On the other hand, figure 14 shows the mixer level, panning and channel configuration for Timang Burung and demonstrates a brief explanation of the mixer window edits in the Cubase DAW. Achieving the target balance and volume levels in the mix, the mix was exported (bounce) to final 2-track stereo wave file at 48 kHz and 24 Bit format to attain the high-resolution quality. This file can be converted or transferred to desirable format of intended playback while attaining the original mix.

[24] LCR: Left, Centre, Right

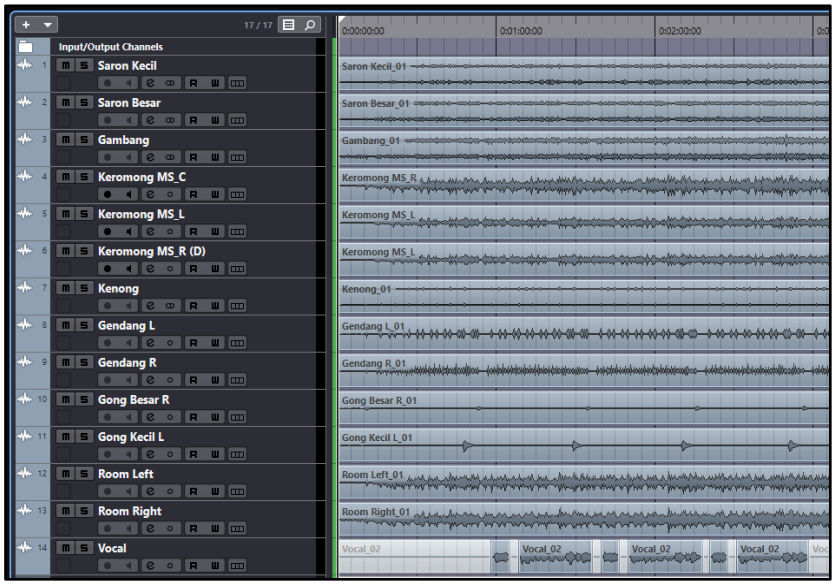


Figure 13: Cubase mixing session for Timang Burung (photo by the author).

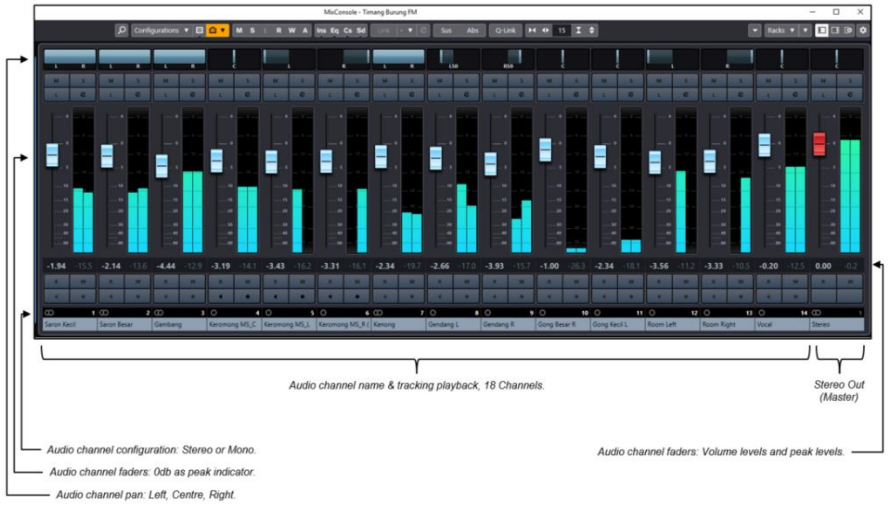


Figure 14: Mixing console for Timang Burung in Cubase (photo by the author).

METADATA

As has been pointed out at the outset of this paper, technical specifications and sound engineering will be crucial in development of the metadata for preservation and archiving purpose. This will enhance the outcome and documentation to achieve the purpose. The metadata would help sound engineers, archivists, field recordists, community members, and musicians in the field of preservation and reproduction of sound creation for future generation. The following is an excerpt from Federal Agencies Audio-Visual Working Group[25] under Federal Agencies Digital Guidelines Initiative (FADGI)[26] (United States or USA):

[25] Audio-Visual Working Group: Focuses its work on sound, video, and motion picture film.

[26] FADGI: A collaborative effort by federal agencies that was formed as a group in 2007 to articulate a common sustainable set of technical guidelines, methods, and practices for digitized and born digital historical, archival and cultural content. The acronym's meaning has been updated in 2017 from Federal Agencies Digitization Guidelines Initiative to the Federal Agencies Digital Guidelines Initiative aimed at reflecting the growing area of this work.

"Embedded metadata can provide information to and support functionality for various persons and systems at a variety of points in the content life cycle. For example, it can help the digitizing unit or organization as it produces and preserves content. It can serve persons or systems who receive content that is disseminated by the digitizing unit or organization. Some metadata elements are especially valuable to internal actors, some to external, and some to both" (FADGI, 2009: 2).

Metadata scheme is accompanied by documentation or data dictionary that describe the data purpose and structure, the number and the names of elements. In doing so, the elements either co-existent with other elements, requirements need to be added or removed. To add on, this is helpful in assessing the usefulness of a metadata scheme for the purpose of data sharing, cross-repository searching, harvesting and transformation or migration, to other scheme or system (ARSC, 2015). Another significant aspect of metadata is not only the descriptive information given to the user or archive details that are used to the identify the content, but it enables the recognition of technical information and the replaying of the audio. Furthermore, it includes the preservation metadata that retains information about the processes that went to generate the audio file. By this, the integrity of the audio content can be guaranteed and the digital archive will depend on comprehensive metadata to maintain its collection. A well-executed plan of digital archive will automate the production of much of the metadata. It should also include the original carrier, its format and state of preservation, replay equipment and parameters, the digital resolution, format, all equipment used, the operators involved in the process and any processes or procedures undertaken (IASA TC04, 2009: 4). Having defined the meaning of metadata, the researcher will discuss two-file formats use for sound preservation and reproduction in this research, Waveform Audio File Format (WAVE or WAV)[27] and Broadcast Wave Format (BWF)[28].

Given the number of linear audio format used to encode audio, we should look into a format with a wider acceptance and use of in professional environment. This ensures the format to have longevity and tools that available to migrate the format to future file formats when necessary. IASA TC04 recommends the use of wave, (file extension .wav) for the simplicity and ubiquity of the linear PCM and the files are widely used in the professional audio industry. As mentioned earlier, the Gamelan Melayu were recorded using wave file format in order to capture the signal and further in the mixing for final output master. As indicated previously for the sound preservation and reproduction, the recorded wave files were accordingly, named and converted to BWF file format with embedded metadata containing the recording information, equipment, visual and guide.

WAVE FILE FORMAT INSTRUCTION FOR METADATA

The wave file format for recording is commonly available in all professional or entry range DAW, for instance, Steinberg Cubase, Steinberg Nuendo, AVID Pro tools, Adobe Audition, Presonus Studio One. Each audio track input was named accordingly to instruments signal that coming in to channel path. Figure 15, shows the incoming channel input track name and

[27] Wave: Waveform Audio File Format is an audio file format standard, developed by Microsoft and IBM. Pulse Code Modulation (PCM) or linear PCM is the uncompressed file format-encoding stream for digital audio and its default-encoding scheme for WAVE.

[28] BWF: Broadcast Wave Format is the de facto standard for digital archival audio created and developed by European Broadcasting Union (EBU) (based on the Microsoft, Resource Interchange File Format (RIFF)) is a generic file container format for storing data in tagged chunks). The file add metadata to facilitate the flawless exchange of sound data between different computer platforms and applications. By specifying the format of metadata, it is allows the audio processing elements to identify by their own, document their activities and it furthermore, supports timecode to enable synchronization with other recordings. This metadata is stored as extension chunks in a standard digital audio WAV file.

corresponding recording result Wave file with the instruments name and number of recording take. Preparing for preservation, archiving transfer and storage after recording and mixing, the researcher followed the recommendation of the Recording Academy Producers and Engineers Wing[29] and AES Technical Council.

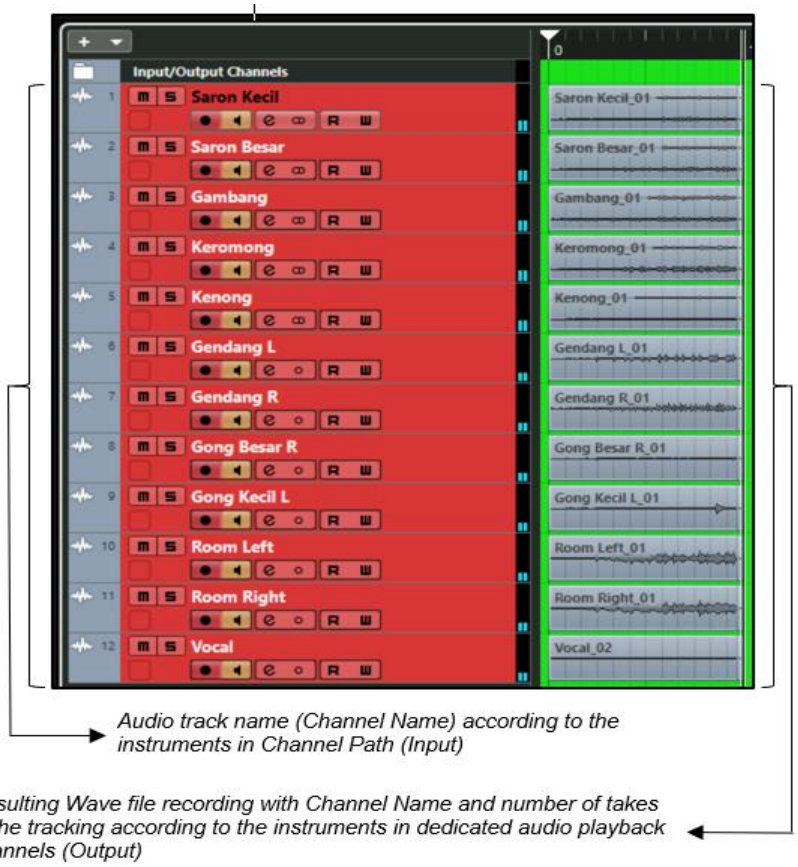


Figure 15: Audio track name (Channel Name) and resulting Wave file name according to the channel name in Cubase (photo by the author).

Both organisations have worked together to come with standardization for material delivery medium, file naming and folder hierarchy for digital storage media backup. There are two recommendations for file delivery and naming, 1. Minimum Delivery Recommendation and 2. Preferred Delivery Recommendation. Following are combination excerpts from AES Technical Council (2014: 4), Recording Academy Producers, and Engineers Wing (2018: 6) delivery recommendations:

The **Minimum Delivery Recommendation** provides the capability to reuse the original recording in the short-term and, if necessary, to re-create the original recording and/or mix as closely as possible. This will allow the owner of the master (generally the Record Label / Content Owner) quicker access to the elements of the project in the use at the conclusion of the mixing process.

[29] Recording Academy: The Recording Academy is an American academy of musicians, producers, recording engineers, and other musical professionals. The Grammy Awards are awards presented by The Recording Academy to recognize achievements in the music industry. The Producers and Engineers Wing (P&E Wing) is part of the academy made up of producers, engineers, mixers, and other technically involved professionals who address the various aspects of issues facing the recording profession. The P&E Wing advices the use of professional recording technology as well as the preservation of recordings.

The **Preferred Delivery Recommendation** provides a more robust solution to the long-term issues that confront Record Labels / Content Owner in their efforts to maintain their assets. It is therefore, the committee's recommendation that all of the audio tracks be "flattened" / consolidated in some work and migrated to the broadcast wave file format.

This delivery recommendation category can vary on the purpose of the recording and preservation works carried out by any preservation or archiving party. In broad term, we could summarise Minimum Delivery Recommendation for 'short usage' and Preferred Delivery Recommendation for 'long usage'. The researcher uses Preferred Delivery Recommendation for the deliverance of this research finding. Upon completion of mixing process, the mixer will be reset (keeping the mixing DAW as whole session as separate backup) to be ensure no any signal or dynamic in apply and fader level in 0dB (unity) without any volume changes. Now, we are ready to name the files for export individually by following the naming conventions in delivery recommendation. In each sound recording, there will be many digital audio files involved. It is important that Wave files contain all relevant information within their file names and are also easy to understand at a glance. For example;

AI_SongTitle_StemName_Stereo/Mono_48k24b.wav
description for the above example as follow,

AI (Artist Initials)	: GG (Gahara Gangsa).
SongTitle	: Timang Burung.
StemName	: Instruments name (Descriptive of audio file).
48k24b	: Audio Track Type, Sample Rate and Bit Depth.
File Extension	: Generally generated during file creation, it should always be shown.

The following figures 16a and 16b show name conventions for Timang Burung Wave file multitrack and mix master. The naming conventions can be done in the file export (bounce) module of Cubase and any other equivalent DAW that were used for preservation.

Figure 16a: Naming conventions for Timang Burung Wave file multitrack (photo by the author).

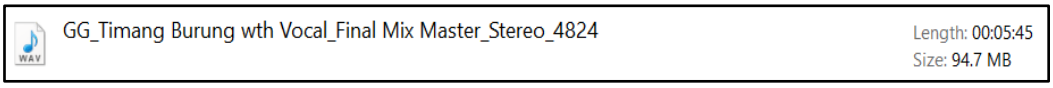


Figure 16b: Naming conventions for Timang Burung mix master (photo by the author).

BWF File Format Instruction for Metadata

There is a broad agreement among professionals that long-term archival storage files and de facto standard file for digital archival audio to be uncompressed Broadcast Wave Format (BWF). The BWF keeps the .wav file extension, it is non-proprietary, and because BWF is limited to two file types of audio data (linear PCM and MPEG), it is interoperable with a wide range of applications and operating systems (ARSC, 2015). This de facto standard file format and enterprise-class storage media provide access to the audio files after the proprietary equipment used to create them may no longer be available. Every effort should be made for each Broadcast Wave File to be a bit-for-bit copy of the original digital tracks. The major benefit of BWF for both archiving and production uses is that metadata can be incorporated into the headers which are part of the file. This is advantage in most basic exchange and archiving scenarios, however, the fixed nature of the embedded information may become a liability in large and sophisticated data management systems. This, and other limitations with BWF, can be managed by using only a minimal set of data within BWF and maintaining other data with external data management systems. It is expected that future development in the area will continue to make the format viable. The BWF format is widely accepted by the archiving community and with the limitations described in mind IASA recommends the use of BWF .wav files [EBU Tech 3285] for archival purposes (IASA-TC04).

The Recording Academy Committee (2018: 10) have said it is extremely important variable in a robust archiving methodology for BWF file naming. There are a number of approaches that the committee reviewed, such as limiting illegal characters as listed by the Operating System (macOS, Windows), or listing the illegal characters. This approach was made to take a more minimalist approach. In doing so, there would be a much higher chance of recovering data over the long-term. BWF addresses the lack of metadata by incorporating additional metadata fields as either a BEXT[30], LIST-INFO[31], axml[32], XMP[33], XML[34] or a iXML[35] chunk[36]. In this research, we use iXML chunk, which is widely adapted by various manufacturers, corporation and galleries include field recorders in location sound metadata. iXML been designed to

[30] BEXT: 'Broadcast Audio Extension' or BEXT is a plain text area of a Wave file wrapped as part of the BWF standard. It provides additional embedded metadata within BWF files. In early development, BWF BEXT description chunk was used in different ways by many vendors to encode some small metadata, but because it is invariably undefined, and lack of space for full information. Whilst many systems tried to read what they could from the bext data, due to no specification and limited space, bext's usefulness was limited. ASCII string allows maximum of 256 characters.

[31] LIST-INFO: A file property and details.

[32] axml: axml chunk may contain any data compliant with the XML 1.0 format or later and it is a widespread format for data exchange. We may have noted that an XML chunk may contain XML fragments from more than one Schema. The axml chunk may occur in any order with the other BWF chunks within the same file.

[33] XMP: 'Extensible Metadata Platform' or XMP file is a metadata file used by Adobe programs such as Photoshop and Bridge. It contains the edits made to a camera raw file, such as a .CR2 or .NEF file, and is automatically generated and saved in the same directory as the corresponding camera raw file.

[34] XML: 'Extensible Markup Language' or XML is a data file. It is formatted much like an .HTML document, but uses custom tags to define objects and the data within each object. XML files can be considered as a text-based database. As they are formatted as text documents, they can be viewed and edited by basic text editors.

[35] iXML: The iXML specification describes a WAV RIFF chunk in BWF files, which contain standard XML data following the iXML. The specification is designed to provide an unambiguous communication of file and project-based metadata between various stages of workflow in production, telecine, picture editorial and audio post-production. The 'i' actually refers to Institute of Broadcast Sound (IBS), and it acknowledges the fact that the IBS played a key role in iXML conception.

[36] Chunk: A chunk is a fragment of information used in many multimedia formats.

standardise the exchange of metadata between these systems, the iXML specification describes a WAV RIFF chunk in BWF files which contains standard XML data following the iXML specification. Figure 17 shows the study conducted by ARSC Technical Committee and audio-visual Preservation Solutions (AVP) to evaluate interoperability and semantic shifts, persistence and integrity through editing operations, and persistence and integrity through derivative creation. Note must be made that iXML is currently going through the standardization process within the Audio Engineering Society.

Chunk	Size	Definition	Adoption	Authority	Extensibility	Storage
bext	Highly Limited	Highly Limited	High	EBU[viii]	None	Must be before data chunk, at the head of the file.
LIST INFO	Flexible	Limited	Somewhat High	Microsoft[ix]	Unclear[x] [xi]	Must be before data chunk, at the head of the file.
iXML	Highly Flexible	Limited, but Extensible	Moderate[xi]	Collection of corporations, website maintained by Gallery	High, may be expanded as needed (registration encouraged)	May appear in any order with the other chunks of the RIFF structure
XMP	Highly Flexible	Somewhat limited, but extensible	In Development within Adobe Products.	Adobe	High, may be expanded as needed (best practices provided)	May appear in any order with the other chunks of the RIFF structure
aXML	Highly Flexible	Highly Flexible	Not commercially available. Apparent internal custom uses within organizations.	EBU[viii]	Very High	May appear in any order with the other chunks of the RIFF structure, requires the file to meet BWF specifications

Figure 17: Assess Options for Embedding Metadata in WAVE Files and Plan the Audio Metadata File Header Tool Development Project: Assessment Report and Initial Recommendations. (http://www.digitizationguidelines.gov/audiovisual/documents/AVPS_Audio Metadata_Overview_090612.pdf).

Technical metadata about digital audio files can be automatically, extracted from the files and exported in a variety of formats, in this research we will using BWF MetaEdit, an open source tool that is useful for embedding metadata in Wave files. FADGI commissioned AVP to develop a free, open source tool that would allow embedding, editing and exporting of metadata within WAVE files. This tool is called BWF MetaEdit (see download version at http://sourceforge.net/projects/bwfmetaedit/. Following are excerpts of BWF MetaEdit features (Lacinak, 2014: 6 -7):

1. Import, edit, embed, and export specified metadata elements in WAVE audio files.
2. Batch and individual operation.
3. Export technical metadata from Format Chunks and minimal metadata from bext and INFO chunks as comma-separated values and/or XML, across a set of files or from individual files.
4. Evaluate, verify and embed MD5 checksums, as applied to the WAVE file's data chunk (audio bitstream only).
5. Enforce specifications developed by the Federal Agencies Audio-Visual Working Group9, as well as specifications from the European Broadcasting Union (EBU), Microsoft, and IBM.
6. Report certain errors in the construction of WAVE files.

7. Interface through command line and GUI, for Windows/PC, Macintosh OS, Linux. (Full list of OS/interface options reviewable at SourceForge)

"BWF MetaEdit is a metadata-centric tool designed to change the landscape of how organizations work with embedded metadata in WAVE files. It is a lightweight, cross-platform tool that can be deployed throughout an organization and used by all stakeholders in the lifecycle of an audio object. Capabilities that were once restricted to specialized audio-centric software usually found only in the audio studio are now made available to everyone, greatly optimizing expertise, increasing efficiency and improving quality assurance of embedded metadata in WAVE files. AVP spearheaded a study in 2010 on behalf of the ARSC TC, evaluating the support for embedded metadata within and across a variety of audio recording software applications to put your new awareness of the issues to work by incorporating new quality control procedures and routines into your audio file workflows. Further, read on the test available on ARSC TC 2011 study paper. In combination with BWF MetaEdit, organizations can use the reference files to test their metadata path when configuring systems and as part of routine maintenance and testing."

The following figure 18 shows the BWF MetaEdit software tool and figure 19 shows a completed iXML list for Timang Burung. It demonstrates how the iXML is accessed and read using simple application such as Windows Notepad. Meanwhile figure 20 presents the conversion of Wave file to BWF by using BWF MetaEdit. For the purpose of the present study, we use Timang Burung Wave file multitrack for example keying in information of the recording and information for reproduction of the sound recording.

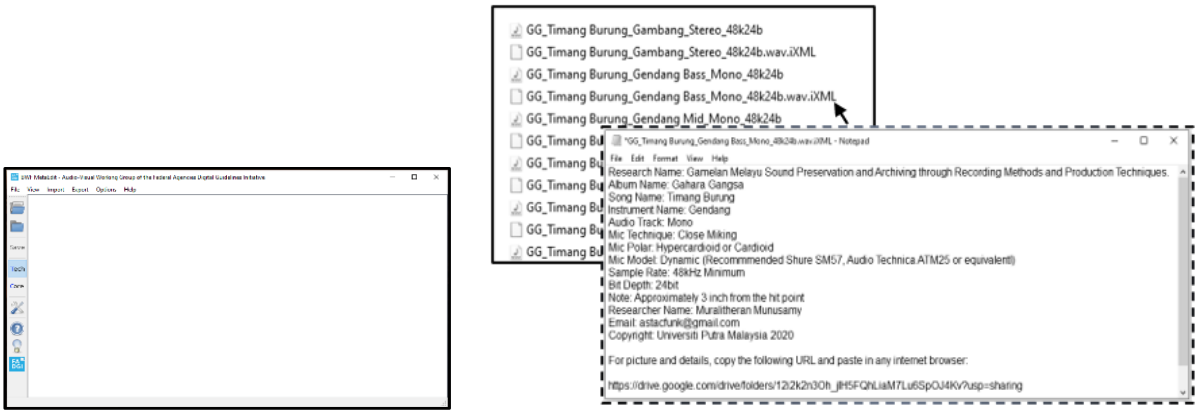


Figure 18: (left) BWF MetaEdit Software tool (photo by the author).
Figure 19: (right): BWF iXML chunk for each instrument used in Timang Burung recordings, the information on iXML can be open in any text software i.e. Notepad in Windows OS (photo by the author).

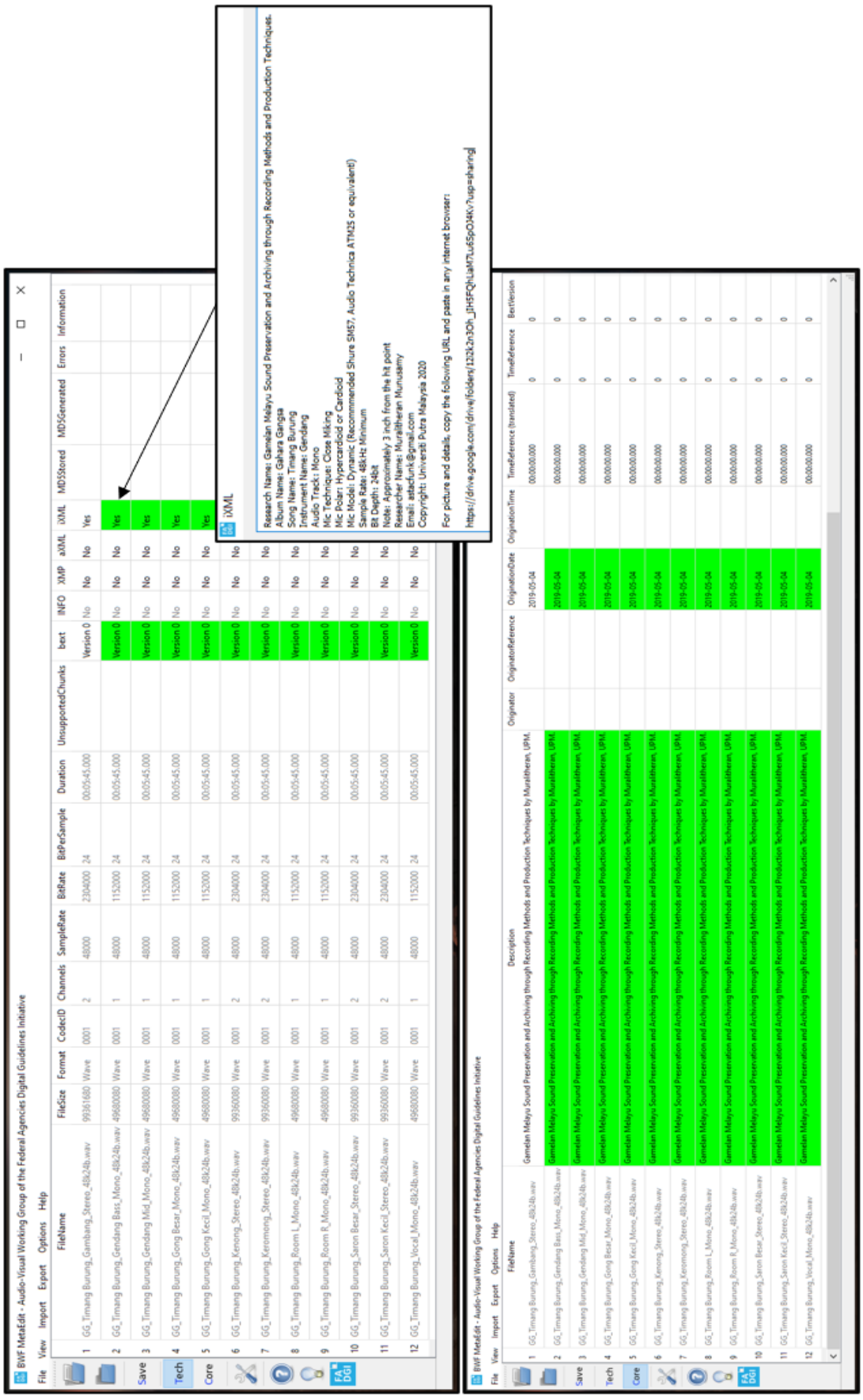


Figure 20: Keying in metadata for Timang Burung repertoire using BWF MetaEdit in Tech and Core mode (photo by the author).

On the other hand, due to the limitation in BEXT information (256 characters), which can be access in the Core mode of the BWF MetaEdit, the information needs to be concise. Figure 21 shows the BEXT information in file attributes of any readable DAW. More details that are technical can be added alongside the description but it is limited such as loudness metering and International Standard Recording Code (ISRC). This section has described the methods applied in this investigation and it has reflected a positive workable method that could be implemented in future for metadata saving's and preservation.

Figure 21: BEXT information in file attributes of the said wave file and this information retrieved by using Steinberg Wavelab (photo by the author).

PROJECT FOLDER HIERARCHY

Both AES TC (2014) and Recording Academy (2018) recommends a folder hierarchy for Producers and Engineers to use during a project to preserve and organize all files during the recording, mixing and mastering phase of the project. This recommendation can be applied to the preservation work as well for the ease use of storage, trace back, referring the source and safekeeping of the files. These folder's names contain the artist identifier (or group, project), song title (repertoire), and contents. Since not all files in the folder may have the same sample rate and bit depth, these are not indicated in the parent folder titles, but they may implemented in the BWF chunk. The project folder contains all parent song mix folders for the project and the multitrack wave files. A parent song mix folder can be created for each song of the project and placed in the project mix folder. The requirements for the folder hierarchy delivery may vary and depend upon the research purpose; therefore, the delivery recommendation committee recommends a minimum delivery setting. Figure 22 is the folder hierarchy of this research work, these folder's hierarchy can be customized as needed according to the sound preservation, archiving or research work. Folders can be added or remove within the hierarchy as appropriate for the project needs.

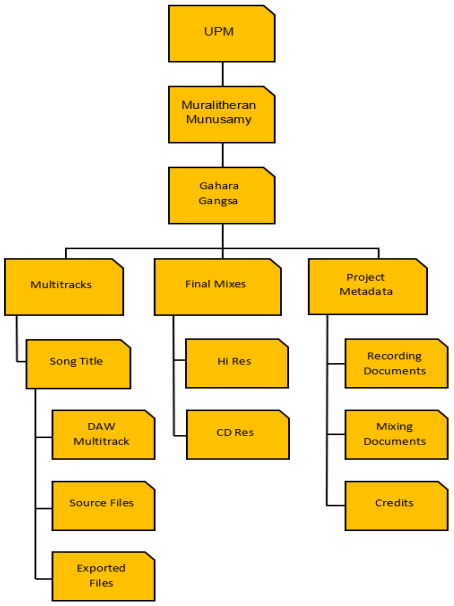
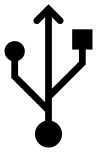


Figure 22: Folder hierarchy of this research sound work filing and delivery (scheme by the author).

STORAGE AND SAFETY

The final storage of this research audio preservation and archiving outcome will be embedded (stored) according to the following methods for retrieval and archiving purpose:

	1. Cloud storage is a subset of public cloud storage that enables the storing of individual or organization's data in the cloud computing and providing the access to the data from anywhere. The digital data is stored in logical pools and the storage spans multiple servers in multiple locations. As long as internet access is guaranteed, the data is available for reach and can be downloaded to be preserved in the local access workstation from internet Uniform Resource Locator (URL) link.
	2. USB pen drive or commonly known as thumb drive is a data storage device that includes flash memory with an integrated USB interface. It is typically removable and rewritable. Compared with physical CDs, they are smaller in term of physical appearance, faster, are compatible to various storage capacity, and are more durable due to a lack of moving parts. They are electromagnetic interference resistant and more importantly they are unharmed by surface scratches (unlike CDs).
	3. Compact Disc (CDs) is a digital optical disc data storage format that was originally, developed to store and play only sound recordings (CD-DA). However, it was later adapted for data storage (CD-ROM). Digital Versatile Disc (DVDs) offer higher storage capacity than compact discs, while possessing the same dimensions. It is often used for storage, data back-up and for the transfer of computer files. With the advancement of storage media technology, they are slowly becoming obsolete.

CONCLUSION

The main objective of this research is to contribute to the Gamelan Melayu Sound Preservation and Archiving through Recording Methods and Production Techniques' by means of infographic documentation (Photos / Diagrams and Schematics of the sound production and reproduction) as well as high-standard audio archiving of the traditional music sound culture in Malaysia. The participation of technical members like audio/sound engineers are crucial in the development of metadata for preservation and archiving purposes. Their expertise in the recording or mixing and mastering will enhance the outcome and as well documenting their approach to achieve the goal. This study serves as a pioneering approach towards recognition, perception and construction of technical specification of audio recording and reproduction information in traditional music ensemble as metadata for preservation. The research findings as guideline, reference, suggestion, protocol and recommendation for traditional music instruments approach regardless of a single instrument or an ensemble, to support the preservation in an effective way. The metadata would help sound engineer, archivist, field recordist, community member, and the musicians in the field of preservation and reproduction of sound creation for future generation.

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