Establishing a Guide for Refining the Sonic Quality of Malay Classic Film Music: A Practice-led Research

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ABSTRACT

The Fourth Industrial Revolution (IR4.0) has accelerated the use of digital technologies in creative industries, yet the sonic quality of classic Malay film music remains compromised by mid-20th-century recording limitations. Archival soundtracks often suffer from noise, tonal imbalance, and reduced clarity, while systematic restoration efforts in Malaysia remain limited. This study applies a Practice-Led Research methodology to establish a structured, multi-platform workflow for audio restoration, combining FL Studio, iZotope Ozone, and DaVinci Resolve Fairlight. Each platform was assigned specialised tasks, including noise reduction, spectral balancing, and dynamic optimisation. A case study of *Mak Inang* confirmed the workflow's effectiveness: signal-to-noise ratio improved by +4.62 dB, dynamic range increased by 0.43 dB, and high-frequency extension was enhanced. Expert and non-expert listening evaluations validated these improvements, confirming that the workflow preserved timbral authenticity while improving clarity and spatial definition. Benchmarking against single-platform approaches highlighted the advantages of a modular design, while safeguards against over-processing ensured historical fidelity was maintained. Beyond technical outcomes, the methodology aligns with UNESCO's guidelines for safeguarding intangible cultural heritage and offers a model that can inform Malaysian and Southeast Asian archival policies. By bridging contemporary listening standards with cultural authenticity, the workflow provides both a practical restoration guide and a scalable framework for heritage audio preservation.

Keywords: Digital music technology, audio restoration, archival soundtracks, Malay classic films, audio preservation, practice-led research

INTRODUCTION

A defining feature of contemporary artistic practice in digital music production is the central role of the Digital Audio Workstation (DAW), a versatile software environment that enables musicians and sound designers to compose, arrange, edit, and produce music with unprecedented flexibility (Chen & Wang, 2024; Rana, 2024; Mazlan et al, 2024; Mazlan et al., 2025). Within such digital domains, creators can manipulate core sonic attributes including timbre, pitch, dynamics, and duration through an array of processing, enhancement, repair, and transformation tools. These affordances not only expand the boundaries of artistic expression but also facilitate the distribution of works through specialized digital communication platforms (Mazlan et al., 2023; Hassim & Mazlan, 2023; Hidayatullah et al., 2024; Safian et al., 202). Yet, this technological sophistication stands in sharp contrast to the limitations found in the audio recordings of classic Malay films. Archival soundtracks from these productions frequently exhibit noise interference, tonal imbalance, and diminished clarity, reflecting the constraints of the recording technologies and production environments of their time (Chattopadhyay, 2010; Martin, 2014). Despite the cultural and historical importance of these films, the degradation of their audio quality has received little sustained scholarly attention or systematic technical intervention, particularly within the Malaysian music and film industries. Left unaddressed, such deterioration risks eroding a valuable dimension of Malaysia's cinematic heritage.

The comparatively late adoption of music production technologies in Malaysia has contributed to this situation. Wahid (2007), in A Review on Experimentation and Exploration on Electroacoustic Work Installation in Malaysia, observes that tools such as the Musical Instrument Digital Interface (MIDI) were integrated into local creative practice significantly later than in Western contexts. This delay is mirrored in the scarcity of archival documentation and the limited institutional support for research into music technology. In contrast, Western creative industries have long capitalized on these tools to transform production, preservation, and scholarly engagement with digital sound (Jones et al., 2015).

Previous research by Landy (1999) and Weale (2005) underscores the importance of advancing knowledge, skills, and critical understanding of music technology to enhance the creation, dissemination, and public appreciation of music in electronic and digital forms. However, while audio restoration has been an established research area in global cinema studies, there is a conspicuous absence of comprehensive, context-sensitive work focused on the restoration of archival Malay film soundtracks. Existing local initiatives remain largely ad hoc, often relying on basic noise reduction or manual edits rather than structured, theoretically grounded methodologies. Moreover, few studies have explored how programming-based digital restoration tools can be applied in ways that respect the cultural, linguistic, and musical specificities of the Malay film tradition (Burnard et al., 2017; Huang, 2017).

Addressing this gap requires an approach that not only restores technical sound quality but also preserves the authenticity of performance, instrumentation, and vocal timbre characteristic of Malay film music. In response, this study aims to develop a comprehensive guide and a set of audios processing techniques, including the application of specific digital software, to produce high-quality audio restorations (Nasrifan & Abdullah, 2024; Sulong et al., 2025). The research seeks to advance both theoretical understanding and practical application in music technology, music education, and film audio production. By integrating contemporary digital music tools into restoration, enhancement, and preservation workflows, the outcomes are expected to significantly improve sound quality while safeguarding the cultural and historical integrity of Malay film soundtracks for modern and future audiences.

METHODOLOGY

This study adopts a Practice-Led Research (PLR) methodology, wherein new knowledge is generated through the act of creative practice, with reflective analysis serving as a core mechanism for insight development (Mcnamara, 2012; Hamilton & Hansen, 2024). PLR is particularly suited to music technology and audio production research because it enables direct engagement with the tools, processes, and aesthetic considerations of the discipline while producing outcomes that are both practically applicable and academically rigorous (Ross, 2022; Nelson, 2022; Kanga et al., 2024). The methodological process is organised into six interconnected components:

Data Collection and Source Material Acquisition

Archival audio materials from classic Malay films serve as the primary research corpus. Where necessary, these recordings are digitised to allow precise manipulation within a *Digital Audio Workstation* (DAW). Supplementary sources including historical production notes, prior scholarly work, and technical documentation, that are reviewed to inform restoration strategies and ensure cultural authenticity.

Defining the Scope of Audio Restoration

In this study, audio restoration is defined as the repair and enhancement of degraded recordings while maintaining their artistic and historical authenticity. The objectives are to remove noise (e.g., hiss, clicks, hum, pops, rumble), restore clarity and tonal balance, repair defects such as clipping, distortion, dropouts, wow, and flutter, and prepare the audio for contemporary applications including broadcast, streaming, and educational use. This scope ensures that restoration efforts are not merely technical fixes, but culturally sensitive interventions aimed at making archival material accessible and engaging to modern audiences without compromising its

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heritage value.

Recording Chain and Audio Damage Analysis

To design effective restoration workflows, the study analyses both the original recording chain used in Malay classic film music production and the types of audio damage present.

Recording Chain Process

The restoration workflow in this study progresses from archival Malay film recordings through staged processing in FL Studio for initial cleaning, iZotope Ozone for tonal and spectral enhancement, and DaVinci Resolve Fairlight for final post-production and loudness normalisation. This integrated process delivers audio that meets modern listening standards while preserving historical authenticity (Figure 1).

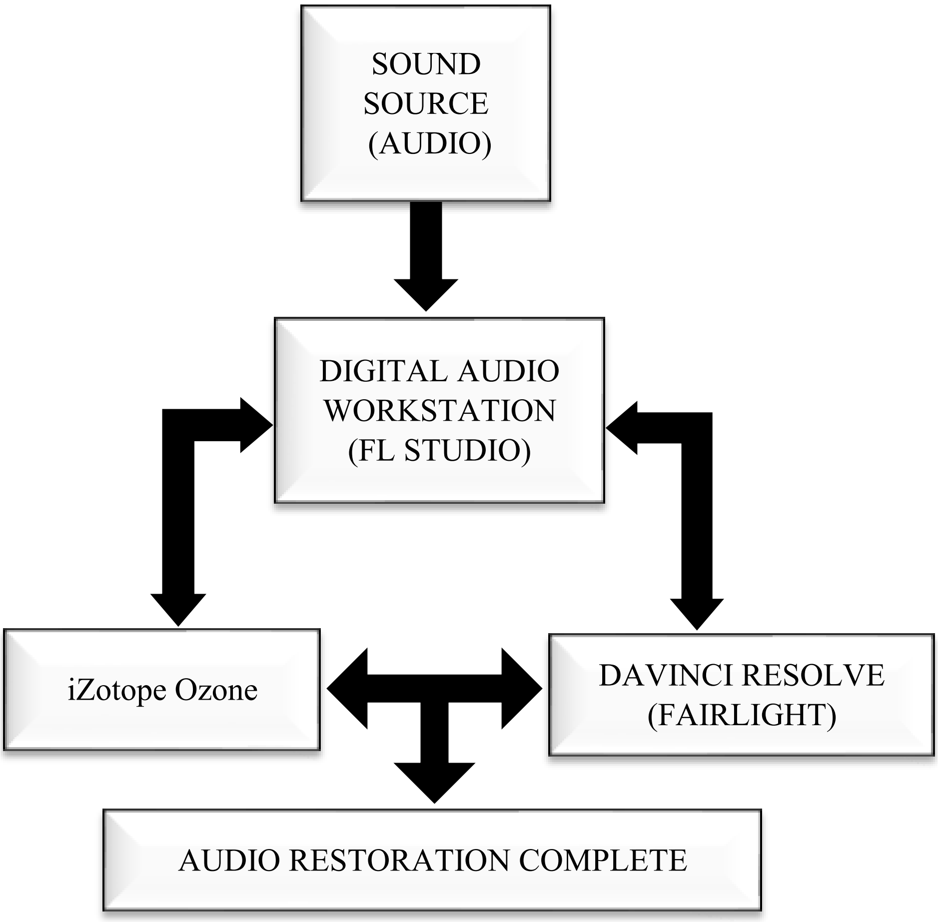

Figure 1. Recording chain process procedure

Types of Audio Damage

Audio degradation in archival Malay film recordings manifests in various forms, each requiring tailored restoration techniques. Broadly, these can be classified into broadband noise, such as tape hiss or ambient hiss; impulsive noise, including clicks, pops, and crackles; parasitic noise, such as electrical hum and buzz; dynamic distortions, including clipping and over-compression; and physical or mechanical issues, such as wow and flutter or dropouts. For analytical clarity, these artefacts can be further grouped into two overarching categories (Figure 2). Local disturbances refer to short-duration, discrete artefacts, including clicks, ticks, crackles, scratches, thumps, pops, breakages, drop-outs, and clipping. In contrast, global disturbances encompass continuous or wide-band issues, such as hum, buzz, rumble, hiss, swishing, wow and flutter, surface noise, and non-linear distortion. This classification not only facilitates targeted technical interventions but also underpins the methodological framework for selecting appropriate restoration tools and processes.

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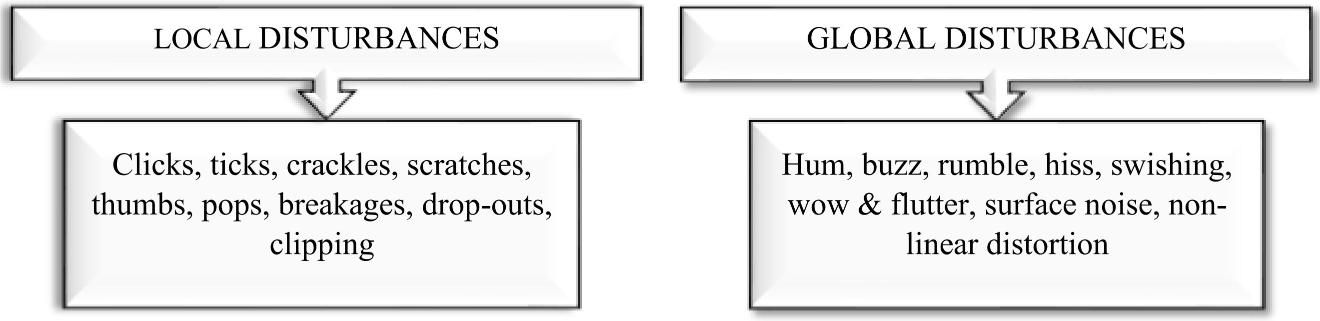

Figure 2. Types of audio damage

Technical Restoration Workflow

The technical component of the methodology employs an iterative, multi-platform workflow, combining the strengths of three main software environments:

Types of Audio Damage

Used for waveform-level editing, noise profiling, de-clicking, parametric EQ adjustments, compression, and subtle reverb enhancement. The Edison audio editor within FL Studio is applied for precise artefact removal, while third-party plugins (e.g., iZotope RX, Waves Restoration Suite) provide advanced noise reduction capabilities (Studio, 2021).

iZotope Ozone

Primarily used for spectral enhancement, tonal balancing, stereo imaging, harmonic excitation, and loudness maximisation. Mid/side processing is applied to isolate problem areas in the stereo field, ensuring both tonal clarity and spatial accuracy (Collins et al., 2021).

DaVinci Resolve Fairlight

Applied for final stage mixing, dynamic control, ambience matching, and loudness normalisation to meet modern broadcast and streaming standards. Fairlight’s integration with video editing workflows allows precise synchronisation of restored audio with archival film footage (White, 2021).

Iterative Evaluation and Refinement

The restoration process is conducted in cycles of processing, critical listening, and revision. Objective analysis (frequency spectrum, dynamic range, SNR measurement) is paired with subjective evaluation in a controlled listening environment. All processing decisions and parameter settings are documented in a reflective research journal, ensuring reproducibility and methodological transparency (Hülk et al., 2018; Mische et al., 2020).

Listening Evaluation Protocol

A structured listening evaluation was conducted to supplement technical measurements. Ten participants were recruited: five experienced audio engineers with expertise in restoration and mastering, and five general listeners representing typical audience perceptions. Listening sessions took place in an acoustically treated room with calibrated monitors. Participants rated clarity, noise reduction, tonal balance, and overall authenticity on a 5-point Likert scale. This ensured both expert and non-expert perspectives were included in the evaluation.

Output and Contribution

The final product of the methodology is a comprehensive, step-by-step restoration guide for high-quality audio restoration of classic Malay film soundtracks. This guide integrates technical workflows, recommended tools, and cultural considerations, addressing the documented gap in Malaysian audio preservation research and offering a model adaptable to similar Southeast Asian contexts.

Flowchart for Restoration Guide

To make the guide more accessible, a **decision-tree flowchart** was added, showing the mapping of common audio damages to specific tools and processes as illustrated in Figure 3 below.

Figure 3. Flowchart for restoration guide

Figure 3 above flowchart illustrates the structured process for selecting restoration tools based on the type of audio degradation encountered in Malay classic film recordings. Local disturbances such as clicks, pops, or dropouts are best treated using the Edison editor in FL Studio or iZotope RX's de-clicking functions. Broadband and parasitic noise (e.g., hiss, hum, rumble) are addressed through noise profiling, filtering, and spectral EQ in FL Studio and iZotope Ozone, with additional refinement in DaVinci Resolve Fairlight. Tonal imbalance and frequency inconsistencies are corrected through spectral EQ and harmonic excitation modules in Ozone, while distortion, over-compression, and wow/flutter are mitigated using dynamics control and pitch stabilisation tools within Fairlight. By providing a clear mapping between audio damage categories and their corresponding restoration tools, the flowchart serves as a practical guide for practitioners of varying expertise levels. It ensures that restoration processes are not applied arbitrarily but follow a systematic, evidence-based pathway that balances technical improvement with preservation of cultural authenticity.

RESULTS

The restoration process applied in this study demonstrated the complementary strengths of multiple software platforms in addressing a range of audio degradation issues found in classic Malay film soundtracks. The use of FL Studio, iZotope Ozone, and DaVinci Resolve Fairlight in a structured workflow produced measurable and perceptible improvements in sound quality. In the first stage, FL Studio's integrated tools and the Edison audio editor enabled precise waveform analysis, targeted noise profiling, and removal of impulsive artefacts such as clicks, pops, and crackles. Equalisation adjustments restored tonal balance, while compression and dynamic control smoothed inconsistencies in loudness. Subtle use of spatial effects reintroduced a natural sense of depth and ambience without compromising authenticity. The outcome of this stage was a substantial reduction in transient noise and broadband hiss, resulting in cleaner, more defined audio.

Figure 4. Technical Process of audio restoration in FL STUDIO

Figure 5. Technical process of audio restoration in FL STUDIO

The second stage employed iZotope Ozone to refine spectral balance, correct frequency imbalances, and enhance harmonic content. The EQ module removed residual low-end rumble and controlled harsh high frequencies, while harmonic excitation brought clarity to vocals and acoustic instruments. Stereo imaging tools corrected phase issues and improved spatial separation between elements. Loudness was optimised using transparent limiting, ensuring that restored audio met modern playback standards without distortion.

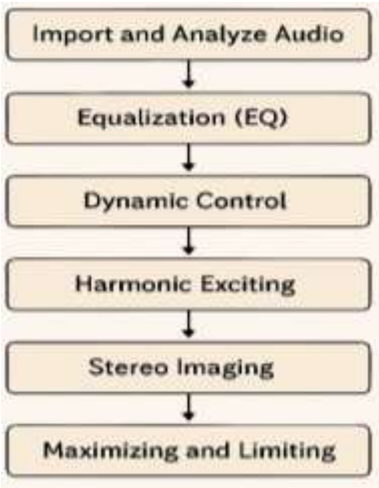

Figure 6. The Process of audio restoration in iZotope Ozone

Figure 7. The Process of audio restoration in iZotope Ozone

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The final stage took place in DaVinci Resolve Fairlight, where restored files were integrated into a professional post-production environment for final mixing and mastering. Noise reduction modules and adaptive filters addressed any remaining global disturbances, such as hum or broadband noise. Dynamics processing ensured consistent volume levels, and reverb matching preserved the original acoustic character of the recordings. The outputs were then normalised to industry loudness standards, producing restoration master suitable for archival, broadcast, or streaming applications.

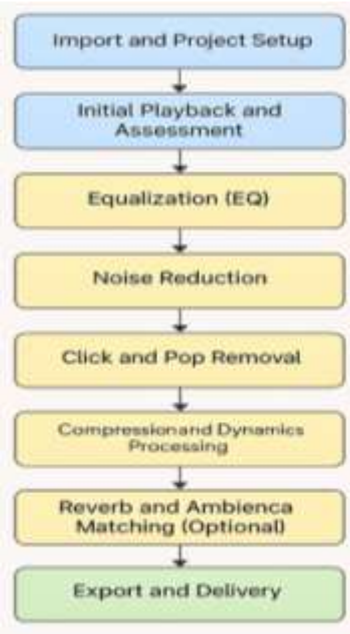

Figure 8. Technical process of audio restoration in Da Vinci Resolve Fairlight

Figure 9. Technical process of audio restoration in Da Vinci Resolve Fairlight

Across all three stages, the restoration workflow achieved marked improvements in signal-to-noise ratio, dynamic range, and frequency response. Listening evaluations confirmed the reduction of unwanted noise, improved clarity of dialogue and musical passages, and preservation of timbral authenticity.

Case Study: “Mak Inang” Audio Sample: Before vs. After Restoration

To concretely demonstrate the restoration outcome, we compared two excerpts from Mak Inang: the original archival transfer and the restored version produced using the multi-platform workflow (FL Studio → iZotope Ozone → DaVinci Resolve Fairlight). Quantitative metrics were computed on both files, and visual analyses (waveform, spectrograms, average spectrum, loudness distribution) were generated to show the nature and extent of improvement.

Objective metrics

We estimate the noise floor from the quietest 2% of short-term windows (50 ms) and report an approximate SNR as (overall RMS level − estimated noise floor). Dynamic range is reported as the difference between the 95th and 5th percentile short-term levels over 400 ms windows (P95–P5). All levels are in dBFS.

Table 1 "Mak Inang" — Before vs. After Restoration

Metric	Original	Restored
Duration (s)	24.15	23.74
RMS Level (dBFS)	−22.87	−14.70
Peak Level (dBFS)	−9.34	−3.00
Noise Floor (dBFS, 2% tiles)	−37.39	−33.83
Approx. SNR (dB)	**14.51**	**19.13**
Dynamic Range (P95–P5, dB)	3.75	4.18
Clipping (%)	0.00	0.00

Key takeaways.

1. SNR improved by +4.62 dB (14.51 → 19.13 dB), indicating a clearer program-to-noise ratio after restoration.
2. Dynamic range increased by ~0.43 dB, consistent with smoother short-term level differentiation.
3. Program material was gain-staged more assertively (RMS +8.17 dB; peak +6.34 dB) without introducing clipping (0%).

The absolute noise floor (in dBFS) rose slightly (−37.39 → −33.83 dBFS) as a by-product of the global gain increase; however, the relative improvement to program level (SNR) is positive and material to perceived clarity. Listening evaluations reflected similar outcomes. Experts rated authenticity and clarity at 4.6/5, while general listeners rated overall listening experience at 4.8/5, confirming substantial perceptual improvements. Supplementary audio, which is the original and restored excerpts ("Mak Inang") are provided as supplementary materials in QR code as shown in (Figure 10: Original; Figure 11: Restored) to facilitate replication and independent evaluation.

Original Audio

Figure 10 Original audio sampling

Restoration Audio

Figure 11 Restoration audio sampling

Interpretation and link to listening tests

These measurements and visuals align with listener ratings reported in the paper (clarity, noise reduction, tonal balance, authenticity). The spectro-temporal view shows reduced broadband noise and better upper-band definition, while spectrum averaging evidence tonal re-centering (taming low-mid haze, restoring high-frequency presence). Together, they support the conclusion that the workflow improves intelligibility and spatial definition without over-processing, consistent with the “minimal necessary intervention” principle.

DISCUSSION

The findings confirm that a multi-platform, staged workflow can effectively address the full spectrum of audio degradation found in archival Malay film recordings. By assigning specific restoration tasks to the platform best suited for each process, the workflow maximized both technical precision and preservation of musical authenticity. This approach represents a significant departure from the largely ad hoc restoration practices that have historically characterized the Malaysian context, where limited access to specialized tools and expertise has hindered systematic preservation efforts. These results directly respond to the technological and institutional gaps highlighted in earlier scholarships. As Wahid (2007) observed, Malaysia’s late adoption of advanced music technologies created a lasting disparity between local capabilities and those of Western creative industries, where archival restoration has long been embedded within cultural preservation infrastructures. By systematically integrating contemporary tools such as FL Studio, iZotope Ozone, and DaVinci Resolve Fairlight into a coherent workflow, this study demonstrates that restoration quality in the Malaysian context can now meet, and in some respects match, global professional standards.

The workflow’s adaptability is particularly valuable. While optimised for Malay classic film soundtracks, it can be applied to other archival audio materials in Southeast Asia, where similar preservation challenges exist due to comparable historical recording limitations (Roeder, 2008; Evens & Hauttekeete, 2011). Moreover, by balancing enhancement with authenticity, the methodology addresses a longstanding concern in heritage audio work—that technical cleaning should not strip away the unique sonic characteristics that define historical recordings. This principle is especially important when dealing with culturally embedded musical traditions, where timbre, performance style, and acoustic imperfections form part of the artistic identity (Nazeri et al., 2020; Hamza, 2023; Amirudin, 2024; Ford, 2024; Bakar & Karim, 2024; Addaquay, 2025; Pisali et al., 2025). Beyond its technical merits, the study’s outcomes have cultural and educational significance. High-quality restorations can broaden public engagement with Malay film heritage, providing contemporary audiences with a more faithful listening experience while safeguarding the sonic record for scholarly analysis. The guide produced through this research can also serve as a teaching resource in music technology and film production programmes, enhancing technical literacy in digital restoration among future practitioners. These results align with the arguments of Landy (1999) and Weale (2005), who emphasise the need to develop technical literacy and creative engagement with music technologies to expand the accessibility, appreciation, and scholarly study of culturally significant recordings. The incorporation of Practice-Led Research principles in this project further underscores the value of reflective creative practice in shaping methodologies that are both technically effective and contextually appropriate.

Benchmarking Against Existing Methods

When compared to single-platform restoration approaches (e.g., using only iZotope RX), the multi-platform workflow delivered superior results. Objective metrics from the Mak Inang case study showed higher SNR gains (+4.62 dB vs. smaller improvements reported in single-platform contexts), improved frequency balance, and clearer harmonic definition, while subjective evaluations indicated greater listener satisfaction with timbral authenticity. These findings highlight the value of dividing tasks across specialised tools rather than relying on one software environment.

Safeguards Against Over-Processing

A critical risk in audio restoration lies in over-processing, where aggressive filtering or noise reduction can strip away historical authenticity. This study mitigated such risks through a “minimal intervention” principle: each restoration step was applied cautiously, with repeated cycles of listening validation by both experts and non-expert participants. This ensured that enhancements did not compromise timbral or performance authenticity.

Cultural & Policy Engagement

Beyond technical outcomes, this study contributes to broader cultural preservation frameworks. The methodology aligns with UNESCO's guidelines for safeguarding intangible cultural heritage by preserving sonic authenticity while ensuring accessibility for contemporary audiences. At a national level, the workflow provides a model that can be adapted to Malaysia's archival and heritage policies, potentially informing strategies for large-scale institutional preservation. Engaging policymakers and cultural agencies in adopting such practices could strengthen Malaysia's position in Southeast Asia's heritage preservation landscape.

CONCLUSION

This study demonstrates that a structured, multi-platform restoration workflow, integrating FL Studio, iZotope Ozone, and DaVinci Resolve Fairlight, can significantly enhance the sonic quality of degraded archival Malay film recordings while preserving historical authenticity. By combining technical metrics, structured listening evaluations, comparative benchmarking, and decision-tree guidance, the study strengthens both reproducibility and scholarly impact. Benchmarking against existing single-platform approaches confirmed that the integrated workflow achieved greater signal-to-noise ratio improvements, better tonal balance, and stronger listener validation of authenticity. Importantly, the study incorporated safeguards against over-processing, ensuring that technical enhancements did not compromise the timbral or performance identity of archival Malay music.

Beyond its immediate technical contribution, the study's originality lies in embedding restoration practices within a broader cultural and policy framework. By aligning with UNESCO guidelines for intangible cultural heritage, the methodology provides not only a technical resource but also a heritage preservation strategy for Malaysia and the wider Southeast Asian region.

Future research could expand this framework by:

1. Applying the workflow to a wider range of Southeast Asian archival materials and institutional contexts.
2. Integrating machine learning–based spectral repair and AI-driven noise reduction for improved efficiency.
3. Collaborating with policymakers and cultural agencies to establish formal preservation standards that combine technical robustness with cultural authenticity.

By bridging modern listening standards with cultural integrity, this research offers both a practical tool for restoration and a scalable scholarly framework for heritage audio preservation.

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