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Interactive Musical Instrument Artwork: Exploring The Intersection Of Waste Management And Cultural Tourism Space In Jathilan, Sumbo Village, Kulon Progo, Yogyakarta, Indonesia

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Abstract:

Purpose – This research aims to address the challenge of preserving the traditional kendang used in Jathilan performances in Kulon Progo, Yogyakarta. The study investigates how recycled materials can serve as sustainable alternatives for musical instrument production, contributing both to cultural preservation and environmental sustainability.

Design/methodology/approach – Employing a design thinking approach integrated with the black box method, the research involves conceptualizing and prototyping an alternative kendang using recycled plastic waste materials such as PVC banners and HDPE plastics. Data were gathered through material testing, acoustic evaluation, and feedback from local artisans and cultural practitioners.

Findings – The resulting prototype exhibits functional and aesthetic qualities comparable to the traditional kendang, while integrating environmentally friendly materials. The prototype demonstrates that cultural identity can be maintained without relying on diminishing natural resources.

Research limitations/implications – This research is limited by the scope of local material availability and the early-stage evaluation of sound durability. Further studies could explore scalability, broader community adoption, and long-term cultural impacts.
Practical implications – It offers a practical example of how design can bridge environmental goals and heritage preservation.
Originality/value – This research contributes original insights by applying recycled materials specifically to Jathilan's kendang, an area yet unexplored in prior sustainability and cultural studies.

Keywords: alternative musical instruments; recycling; Jathilan; sustainability; cultural tourism

INTRODUCTION

The development of the tourism area in Kulon Progo is part of the central government's policy related to the Borobudur super-priority destination (BOB) 2022). As an internationally renowned historical and cultural site, Borobudur attracts tourists both domestically and internationally (Akbar and Pramadika 2021). The potential of cultural arts and the Jathilan performance in Kulon Progo is one of the main attractions for both local and foreign tourists (Ramadhan, Astono, and Parmenas 2020). Jathilan, as a form of traditional art rich in meaning and cultural values, holds significant potential to become a key attraction in the region's tourism industry (Browne 2003).

The increasing scarcity of traditional musical instruments for Jathilan, such as kendang drums made from jackfruit wood, highlights the need to find alternatives to sustain this art form and its performances. Therefore, this research aims to create innovative solutions in the form of musical instruments for Jathilan performances, utilizing recycled materials and aesthetically creative designs. Waste is one of the main societal problems that can actually be repurposed, especially with creative and aesthetic designs. One type of waste that exists in large quantities and is difficult to recycle is used banners or posters, particularly from political campaigns or local elections. These banners are processed into a type of multiflex material that can be shaped into various products, one of which will be experimented with in the production of uniquely designed Jathilan kendang drums.

By integrating art, technology, and environmental sustainability, this study explores the potential of waste as a raw material to create unique and appealing musical instruments for Jathilan performances (Asanti, Budaya, and Mulawarman 2022). In addition to offering solutions for waste management, this initiative also adds aesthetic value and uniqueness to the tourism experience.

Green tourism is a key aspiration for the agritourism sector developing in Kulon Progo. Tourism should not only contribute to economic growth and social progress but also serve as a cornerstone for harmony between humans and nature (Astono et al. 2023). This vision forms the foundation of this research.

The problem statements in this study are as follows:

1. How can alternative musical instruments for Jathilan be creatively and aesthetically designed as an effort to manage plastic waste in the Sumbo, Samigaluh, Kulon Progo, Yogyakarta area?
2. How can the prototype of alternative musical instruments for Jathilan be evaluated in terms of its validity, practicality, and effectiveness?

LITERATURE REVIEW

Art

The concept of art refers to the ideas or notions that form the foundation for creating artworks. It encompasses various elements such as themes, colors, lines, shapes, textures, and space (Ganap

2012). The concept of art provides direction or purpose for an artist in creating their works. It can also include the message or meaning that the artist wishes to convey to the audience through their creations (Nurfatoni 2013).

Jathilan Attraction

Jathilan is a traditional art performance originating from Central Java and Yogyakarta, Indonesia (Browne 2003). It is typically performed during traditional ceremonies or cultural festivals as part of community entertainment. Jathilan involves a group of dancers dressed in horse-like costumes made from woven bamboo and fabric. They perform while playing traditional musical instruments such as kendang drums, gongs, and angklung (Rochayanti et al. 2019). Moreover, Jathilan is considered a form of cultural celebration and ritual that strengthens social bonds and unity within Javanese communities Jawa (Syah et al. 2019).

Waste Management

Waste management in the context of musical instrument production involves the process of repurposing waste to create functional and aesthetic instruments. This approach includes utilizing recycled or discarded materials, such as reclaimed wood, plastic bottles, or scrap metals, to craft musical instruments (Yusri 2020). By adopting sustainable waste management principles, this process not only reduces the amount of waste entering the environment but also adds value to materials previously considered as trash (Dunmade 2013). It contributes to environmental conservation and carbon footprint reduction while promoting awareness of the importance of efficient and responsible resource usage in the music industry (Setyoko et al. 2022).

Cultural Tourism

Cultural tourism, especially in the context of arts and attractions, refers to tourism experiences that showcase the cultural heritage of a destination (Choirunnisa et al. 2021). The purpose of cultural tourism is to promote and preserve the cultural heritage of a community or region while introducing it to visitors from outside (Sugiyarto and Amaruli 2018). Additionally, cultural tourism contributes to the local economy by creating job opportunities in the tourism sector, expanding markets for local artists and artisans, and increasing revenue from the tourism industry (Pajriah 2018).

Table 1: State of the Art

Name & Year	***Title & Journal***	***Research Findings***
Rahmat Kurniawan (2023)	*Instrumen Tiup Puik-Puik Dalam Perspektif Ekomusikologis: Pedagogis, Alam Dan Budaya* Selonding Jurnal Etnomusikologi Vol. 19 No. 2	Ecomusicology serves as a tool that can benefit many and bridge the gap between nature and culture, particularly in the field of music.
Setyoko, Aris et al. (2022)	*Pemanfaatan Barang Bekas Pakai Sebagai Alat Musik Sederhana Pada Workshop Musik Perkusi Di Sman 2 Samboja* Ruhui Rahayu: Jurnal Pengabdian kepada Masyarakat Vol. 1 No. 1	Community service activities showed participants' tendency to enhance and refine their musical intelligence while fostering environmental awareness through the use of recycled materials in crafting simple musical instruments.
Israel Dunmade (2013)	*Environmental Profile Assessment Of A Plastic Framed Tambourine Musical Instrument – A Lifecycle Approach* Journal Sapub.org Vol. 3 No. 5	Each plastic tambourine has a Global Warming Potential of 664.065 kgCO2-eq and an Ozone Depletion Potential of 0.227 kgCFC-11-eq.
Ali Ozturk (2012)	*The Evaluation of Success in Raising Environmental Awareness Through the Musical Instruments Produced Within the*	The primary aim of the study was to evaluate the contribution of musical instruments to raising environmental awareness among students as part of the

	Scope of ECO Schools Program Implemented in Eskisehir Procedia - Social and Behavioral Sciences 51 (2012): 828–831	ECO Schools Project. The findings showed increased awareness and creativity in crafting instruments from waste materials.
Aaron S. Allen (2017)	*Sustainable Futures for Music Cultures: An Ecological Perspective* Ethnomusicology Forum 26/3 (2017): 400–405	This book, involving 14 specialists, explores diverse musical practices globally using a framework for preserving endangered traditions, based on UNESCO conventions and initiatives for intangible cultural heritage.

Source: Researcher's Compilation (2024).

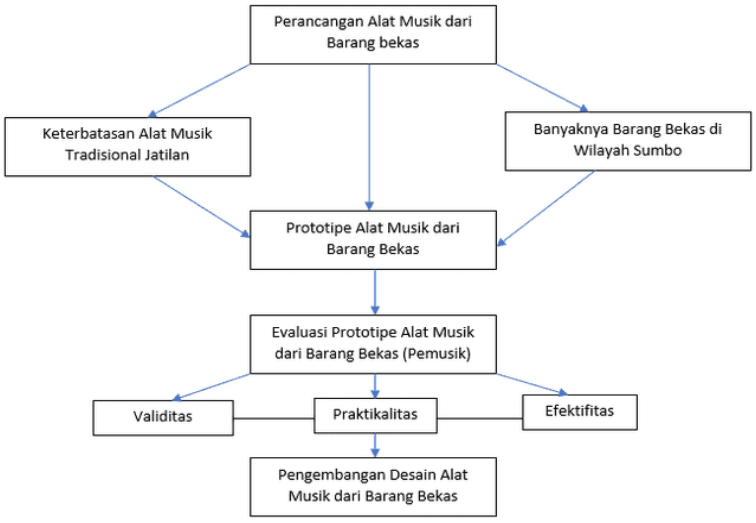
METHOD

This research adopts a design thinking approach, focusing on creative problem-solving through a deep understanding of user needs and the sociocultural context. This approach enables researchers to systematically formulate the problem by identifying the challenges faced in developing traditional Jathilan musical instruments made from increasingly scarce raw materials.

Subsequently, the researchers conducted an analysis of relevant previous studies to understand trends and innovations in the development of musical instruments made from recycled materials. This process was complemented by in-depth interviews with traditional Jathilan musicians, providing valuable insights into their practices, preferences, and challenges in using traditional musical instruments. The data gathered from these interviews were combined with the researchers' design ideas, resulting in a comprehensive analysis that focuses on cultural relevance.

The visual design of the developed musical instruments was evaluated by various stakeholders, including musicians, artisans, and local art enthusiasts, before execution. This evaluation phase was essential to ensure that the resulting design not only meets aesthetic standards but also aligns with practical needs and existing traditions. This method integrates analysis, data collection, design, evaluation, and execution in a structured manner, aiming to produce musical instruments made from recycled materials that are not only aesthetically pleasing but also ergonomic.

Through this approach, the research does not only create sustainable and innovative musical instruments but also strengthens local wisdom and the cultural values of Jathilan. By leveraging user-centered design principles, this study contributes to cultural preservation efforts while promoting innovative solutions in waste management. The following is the conceptual framework for this research:



Source: Research Results

Figure 1: Framework for Designing Musical Instruments from Recycled Materials

Description of Steps Taken:

1. Identification of Limitations in Traditional Jathilan Musical Instruments
   a. Researching the types of traditional Jathilan musical instruments.
   b. Identifying the limitations of traditional Jathilan instruments, such as raw material availability, production difficulties, sound limitations, and functional constraints.
2. Mapping of Recycled Materials
   a. Recording the types and quantities of recycled materials.
   b. Categorizing recycled materials based on their potential use as musical instruments.
3. Designing a Prototype of Musical Instruments from Recycled Materials
   a. Designing new musical instruments utilizing recycled materials.
   b. Considering factors such as aesthetics, functionality, safety, and ease of production.
4. Evaluation of the Musical Instrument Prototype
   a. Conducting trials of the musical instrument prototype by traditional Jathilan musicians.
   b. Gathering feedback and suggestions regarding sound quality, user comfort, and functional accuracy.
5. Validation, Practicality, and Effectiveness
   a. Conducting validity tests to ensure the new musical instrument meets the needs and traditions of Jathilan.
   b. Assessing the practicality and effectiveness of the new instrument in supporting Jathilan performances.
6. Design Development
   a. Refining the design of the musical instrument based on the results of evaluations and validations.

Addressing aspects such as aesthetics, functionality, safety, ease of production, production costs, and durability of the instrument.

RESULTS AND DISCUSSION

Identification of Material Limitations for Kendang Musical Instruments

The scarcity of materials for making kendang drums in Yogyakarta, particularly wood, poses a significant challenge for artisans. Traditionally, kendang is crafted from high-quality wood such as jackfruit, coconut, or mahogany, which are valued for their excellent acoustic properties and durability. However, over time, the availability of quality wood in the region has declined due to several factors, including high demand and deforestation. For instance, jackfruit trees, commonly used for their fine grain and resonant sound, require years to mature before they can be harvested, making sustainable production difficult. Similarly, mahogany and coconut wood face similar issues related to scarcity and inadequate forest management.

In addition to availability challenges, the wood used for kendang production requires a lengthy drying process. Proper drying aims to reduce the wood's moisture content to an ideal level, preventing cracks and deformation during use. In Yogyakarta, the humid tropical climate often slows the natural drying process, which can take months. Uneven or overly rapid drying can make the wood prone to cracking, compromising the drum's structural and acoustic quality.

In response to these limitations, some innovations have been introduced by exploring alternative materials such as multiflex, a recycled material made from PVC banners. The use of multiflex, sourced from discarded campaign banners, has been tested as a substitute for wood in kendang production. While this material offers a sustainable solution, it presents challenges in achieving sound quality. Wooden kendang has natural resonance characteristics that are difficult to replicate with synthetic materials. Artisans must make technical adjustments, including bending and arranging the multiflex material, to achieve acoustic performance comparable to traditional kendang.

Amid these constraints, there is an urgent need for kendang artisans in Yogyakarta to adapt, either by using modern technologies or by implementing more sustainable material management practices. Alternative materials like multiflex offer a promising solution, but further refinement in crafting techniques and adjustments to acoustic properties are essential to ensure that the resulting kendang meets traditional quality standards.

Mapping Recycled Materials (Flexi Banners)

In the month following the 2024 general election, approximately 11 tons of campaign banners were collected from five regions: South Jakarta, East Jakarta, Central Jakarta, Depok, South Tangerang, and the Special Region of Yogyakarta. This collection effort was part of a systematic initiative in post-election waste management aimed at supporting recycling initiatives and reducing the environmental impact of accumulated campaign materials. Part of the collected banners is planned to be processed into raw materials for making Jathilan kendang drums, leveraging recycled materials to create cultural products with added value.

Flexi banners, as a type of waste, are difficult to recycle. Therefore, appropriate mechanisms are needed to enable effective reuse or recycling. One finding from the material mapping process was the prevalence of plastic waste that cannot be processed by the local community due to a lack of knowledge and tools. Consequently, this material mapping involved members of the Kali Manggis Waste Bank in Sumbo Village, Gerbosari, Samigaluh, Yogyakarta. Training sessions were conducted on waste management, including explanations about the design and processing of flexi banner waste into innovative musical instruments.

Source: Research Results

Figure 2. Piles of Used Flexi Banners

Design Process

The design process was carried out through several stages, starting with the creation of a managerial workflow. This workflow helps optimize the allocation of time and resources, improve efficiency, and ensure quality control and technical adjustments. This is particularly crucial in the fields of art and design, where process management is often overlooked. Moreover, since multiflex material has never been used to make kendang before, flexibility in adjusting the design is essential if experimental results do not meet expectations.

The prototype design of the Jathilan kendang utilizes multiflex material, a recycled material made from PVC banners that serves as a substitute for jackfruit wood. Developed by Stuffo and GudRnD, multiflex material is strong yet elastic. The multiflex boards, measuring 90 x 20 x 1 cm,

require technical adjustments during the kendang design process. This process also necessitates additional references regarding technical aspects and design forms to achieve optimal results.

Form, Size, and Technical References

The process of making Jathilan kendang using multiflex material requires an in-depth study to ensure the adaptation of techniques from traditional wood-based production to modern recycled materials, such as PVC (Polyvinyl Chloride). Traditionally, kendang drums are made from natural woods like jackfruit, coconut, or mahogany, through a series of steps including material selection, cutting, shaping into a cylinder, surface smoothing, and creating resonance holes to enhance acoustic quality. The final stage involves attaching and tensioning drum skins, stretched using rattan ropes or other materials, to produce optimal sound.

In the context of making kendang using multiflex, the material used is significantly different from wood, necessitating technical adjustments. Multiflex is a recycled material derived from PVC flexi banners, processed through heating to produce boards measuring 90x20x1 cm. To adapt traditional techniques for multiflex kendang production, references to the coopering or cooperage process, commonly used in wooden barrel-making, become relevant. Coopering involves arranging wooden staves into a circular formation and securing them with metal rings to create a cylindrical shape. This technique inspired the approach to producing Jathilan kendang with multiflex, where multiflex boards are arranged and secured to replicate the structure and function of wooden kendang shells. These adjustments aim not only to retain the aesthetics and functionality of the kendang but also to ensure that the alternative material delivers sound quality comparable to traditional wooden kendang. Integrating recycling technology into this process highlights the potential for sustainable innovation in the traditional musical instrument industry.

Technical Process

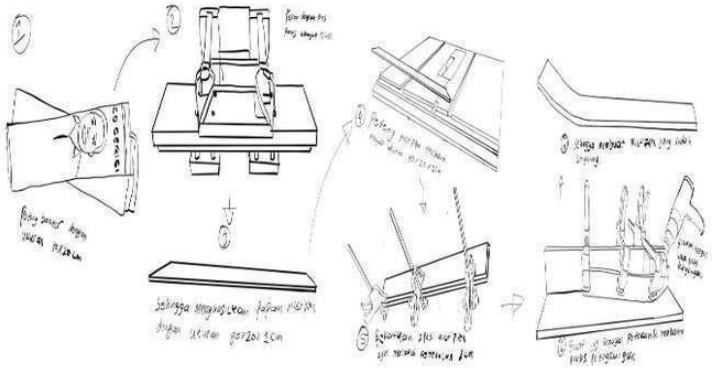
The production process of the recycled multiflex material involves a systematic workflow starting from collection to forming the material into staves for kendang production. The initial stage involves collecting used banners from the 2024 general election campaign, with approximately 11 tons of banners gathered from several regions, including South Jakarta, East Jakarta, Central Jakarta, Depok, and South Tangerang. This initiative is part of an effort to manage campaign waste and add value to discarded materials through recycling. The collected banners are intended to be converted into new materials for cultural products, including Jathilan kendang drums.

Following collection, the banners are cleaned to ensure the material is free from dust, dirt, and adhesive residue that could affect the quality of the recycled product. The cleaning process is done using water and mild detergent, followed by thorough drying to remove moisture before further processing. This step is crucial to ensure the material is in optimal condition for processing, maintaining the quality of the recycled material for efficient production.

The next stage is cutting and shaping the banners into multiflex material. The banners, which come in various shapes and sizes, are cut to match the dimensions of the press machine used (90x20 cm). This cutting pattern adjustment is essential to optimize machine usage and minimize waste, ensuring production efficiency. To form staves measuring 40x5x2 cm, the cut banners are stacked and glued using polyurethane (PU) adhesive to achieve the required thickness. The resulting staves are then softened and bent to the desired radius using heat gun methods.

Two bending methods were tested in this process: bending with and without heating. The results showed that the bending method without heating produced faster and more uniform results, although the resulting shapes were slightly angular. Conversely, bending with heating produced better radius

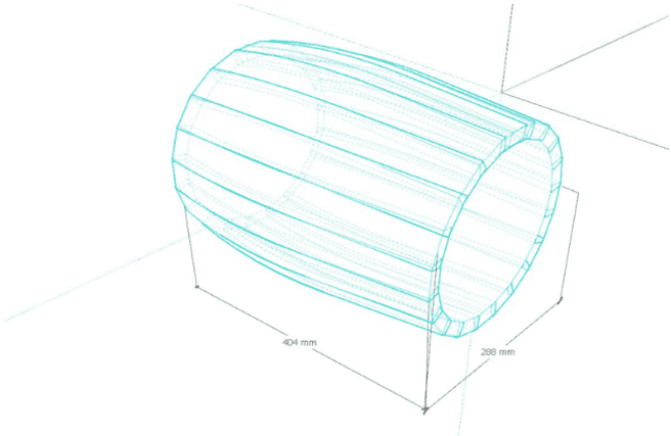
consistency as the multiflex material adhered more easily to the curvature of the mold, although there were inconsistencies in the radius between staves. This experiment highlights the importance of the heating process in bending elastic materials like multiflex but also indicates the efficiency potential of non-heating bending methods for large-scale production. Below is an illustration of the production process in sequential order:



Source: Research Results

Figure 3: Multiflex Bending Process

Once the multiflex material is bent, the focus shifts to working on the staves. The process of creating a Jathilan kendang using multiflex staves involves precise calculations regarding the number and dimensions of each stave to match the desired design. Each stave is 5 cm wide, and to form a kendang with a diameter of 20 cm, the correct number of staves is required to achieve the ideal circumference. Based on the circumference formula ($C = \pi d$), a kendang with a 20 cm diameter has a circumference of approximately 62.8 cm. To cover this circumference, around 13 staves are needed (62.8 cm / 5 cm ≈ 12.5, rounded up to 13 staves).



Source: Research Results

Figure 4: Staves Forming a Barrel

Once the staves are assembled into a barrel, the shape of the kendang becomes apparent and is prepared for the addition of a membrane, which is also made from thinner multiflex material. This membrane is secured with a kendang ring that allows the tension to be adjusted, enabling the membrane to produce sound frequencies similar to those of a traditional kendang.

Using an experimental approach and digital design tools like SketchUp, this process provides a comprehensive overview of the transition from recycled materials to a cultural product. This not only

supports environmental sustainability but also introduces innovation in the production of traditional musical instruments.

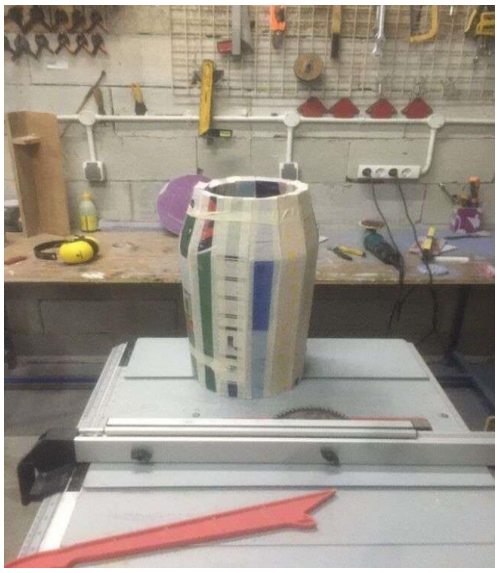
Kendang Prototype

A study on the use of multiflex material for kendang production compared to traditional wood materials reveals significant differences, particularly in terms of thickness and weight. Multiflex, a recycled material made from PVC banners, has distinct physical characteristics compared to natural woods like jackfruit or mahogany, which are commonly used in traditional kendang production. One of the key differences lies in the thickness of the material and the overall weight of the resulting kendang.

In terms of thickness, the multiflex material used in the kendang prototype measures approximately 2 cm, which is about 0.5 cm thicker than traditional wooden kendang, which typically have a thickness of around 1.5 cm. This added thickness is necessary to compensate for the lower structural strength of the recycled material compared to wood. While this increase in thickness helps reinforce the walls of the kendang, it also impacts the sound characteristics produced. Traditional wooden kendang with thinner walls can produce more natural resonance, whereas the thicker multiflex material tends to produce a more muted and less powerful sound.

Another notable difference is the weight of the material. The multiflex kendang prototype is nearly twice as heavy as a small kendang made from natural wood. Although multiflex is lighter than wood overall, the increased quantity required for added thickness and stability significantly increases the weight. For example, while a small wooden kendang might weigh around 3 kg, a similarly sized kendang made from multiflex could weigh 5–6 kg. This added weight also affects the performance of the kendang, as heavier instruments tend to vibrate differently when played, influencing the quality of the sound produced.

With its greater thickness and weight, the multiflex kendang prototype faces challenges in replicating the acoustic quality of traditional wooden kendang. The natural resonance produced by lighter, thinner wood is difficult to achieve with the thicker and heavier multiflex material. Nonetheless, the use of multiflex remains promising as a sustainable alternative in musical instrument production, with potential for further optimization in production techniques and sound adjustments. Below is an image of the kendang prototype, which is 90% complete.



Source: Research Results
Figure 5. Kendang Body Prototype

The showcased kendang prototype demonstrates an innovative effort to utilize recycled materials, such as multiflex, as a substitute for traditional wood. Multiflex, derived from recycled flexi banners, serves as the primary material for this kendang, evident from its distinctive colorful patterns. The use of this material reflects an exploration of sustainability in the production of traditional musical instruments, despite the differences in weight, durability, and acoustic properties compared to wood. The production process appears to be in its initial stages, with a cylindrical structure already formed but yet to be refined in detail.

The application of stave-joining techniques (assembling pieces of material) is evident in constructing the kendang body, with temporary adhesives or tape used to hold the staves in place before further assembly. This technique is commonly employed in kendang-making, particularly for bending materials to fit the desired shape. However, since multiflex has different elastic properties compared to wood, handling this material requires specialized methods, such as using heating tools to achieve the perfect shape.

Additionally, the workspace utilizing manual tools and wood-cutting machines indicates that the techniques for crafting multiflex kendang still rely on traditional methods, despite the use of a different material. The unfinished stave cuts and rough lines on the kendang body suggest that this is still an early assembly stage. Finishing stages, such as sanding and surface smoothing, are yet to be carried out, implying that the prototype will likely undergo further refinements before becoming a functional kendang. Overall, this study showcases a promising experiment in exploring alternative materials for kendang production, though further development is needed, particularly in completing the construction and improving sound quality.

Validation and Design Development

The validity study of the kendang innovation made from recycled flexi banners reveals the following findings: The sound quality produced by the current kendang shows improvement but has not fully achieved the frequency of an original kendang. This may be due to the material's thickness, which is stronger and heavier. While the durability and longevity of the instrument are positive aspects, their impact on acoustics and sound resonance must be addressed. Thicker materials often alter the character of the sound produced, making the kendang unable to deliver the desired nuances and harmony. Therefore, further research is necessary to explore alternative materials that can enhance resonance without sacrificing durability.

In terms of musical function, the kendang's design, which closely resembles traditional kendang, makes it suitable for various performances, including Jathilan. This visual similarity provides an advantage for adapting the instrument in traditional performances, where audiences often have specific expectations regarding the appearance of musical instruments. However, frequency calibration is crucial to ensure the kendang produces sound consistent with the characteristics of wooden Jathilan kendang. Testing and adjusting sound frequencies through experiments and collaboration with local musicians can enhance the quality of the kendang to better meet expected frequencies.

Overall, while the current kendang shows potential for use in various contexts, challenges in achieving ideal sound quality and frequency alignment with the original kendang remain a primary focus in design development. By addressing material and frequency aspects and involving musicians in the testing process, the kendang can evolve to meet the needs of modern music without losing its

traditional roots. This approach will not only enhance musical quality but also strengthen the cultural identity embedded in the instrument.

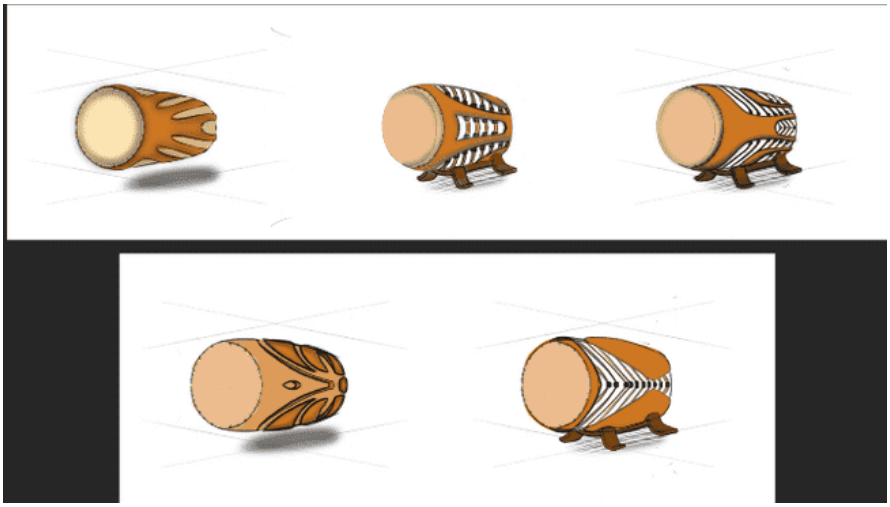
Design Development Insights

The kendang design, which integrates traditional and modern elements through the use of graphics on the drum shell, represents an innovative step reflecting cultural adaptation in a contemporary context. This design process considers not only aesthetics but also sustainability by utilizing recycled materials. The use of shredded PVC banners and HDPE plastic waste to create new materials with a thickness of 4–5 mm significantly contributes to waste reduction while producing an attractive and functional product. The variety of colors resulting from the recycled plastic, such as bottle caps or flexi banners, enriches the visual appeal of the kendang.

The flexible and elastic properties of this material make it ideal for application on the kendang shell, where flexibility and ease of installation are key. The design, which follows pre-designed motifs, ensures consistency in aesthetics while providing room for creativity and personalization. This not only enhances visual appeal but also invites artisans and musicians to engage more deeply in the creative process, transforming the kendang into not just a musical instrument but also an artwork reflecting cultural identity and innovation.

Furthermore, the development of this kendang design can be explored through collaboration with graphic designers and local artists to create more diverse motifs that reflect local cultural characteristics. By involving the community in the design process, the kendang can become a medium to express stories and traditional values relevant to younger generations. Additionally, the use of digital printing technology can expand possibilities for creating complex and detailed graphics, enriching the kendang's visual appeal while preserving its traditional essence.

From a marketing perspective, this design approach can attract consumers who are environmentally conscious and value art, opening up opportunities for a broader market. By emphasizing uniqueness and innovation, kendang with modern graphic designs can become a symbol of a shift in the musical instrument industry, where tradition and modernity complement each other. Through sustainable and collaborative development, the kendang will not only remain relevant but also become an icon of a dynamic and adaptive culture. Below are some of the design development results currently planned:



Source: Research Results

Figure 6. Kendang Barrel Design

CONCLUSION

Based on the two research questions posed, the conclusions of this study can be explained as follows:

1) Designing Creative and Aesthetic Alternative Musical Instruments for Jathilan
   The design of alternative musical instruments for Jathilan, focusing on plastic waste management, successfully created innovations that combine creative and aesthetic aspects. By utilizing recycled materials such as PVC banners and HDPE plastics, the design process not only addresses environmental challenges but also preserves cultural values. The resulting kendang demonstrates that through innovative design approaches, traditional musical instruments can be adapted using more sustainable materials without compromising functionality. This process involved collaboration between artisans, designers, and local artists, creating opportunities for creative exploration that reflect local cultural identity. Therefore, this alternative musical instrument design contributes not only to waste reduction but also enriches cultural heritage in a way that is relevant to current generations.
2) Evaluation of the Prototype Musical Instrument in Terms of Validity, Practicality, and Effectiveness
   The evaluation of the alternative Jathilan musical instrument prototype indicates that while there are improvements in sound quality, challenges remain in achieving the desired acoustic characteristics. The validity of this prototype is evident in its shape and function, as the designed kendang visually resembles traditional kendang. However, the main challenge lies in adjusting the sound frequency to approximate that of original wooden kendang. In terms of practicality, the prototype can be used in various performances, though further testing is needed to ensure optimal sound quality. The effectiveness of using recycled materials also shows potential in creating sustainable musical instruments, although craftsmanship techniques and acoustics need to be improved to meet the expected quality standards. By involving musicians in the testing and adjustment process, this kendang has the potential to continue evolving and meet the needs of modern music while respecting its traditional roots.

Overall, this research emphasizes that the design and development of alternative musical instruments should focus not only on technical aspects but also on the integration of innovation, sustainability, and cultural values. This approach opens new opportunities for exploration and innovation in the musical instrument industry, enabling traditional instruments to remain relevant in a changing era.

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CONFLICT OF INTEREST

This research was supported by a government grant; however, the authors declare that there is no conflict of interest. The funding body had no involvement in the design, execution, analysis, or interpretation of the research findings.

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