SIIDEF | Sewon International Industrial Design Fair

SIIDEF

Sewon International Industrial Design Fair
Proceeding International Conference

Act Locally, Design Globally: Empathy in Local Innovation
(From Local Insights to Global Impact)

At R.J. Katamsi Gallery ISI Yogyakarta

Editor: Drs. Baskoro Suryo Banindro,M.Sn. - Nandang Septian, M.Ds.

SEWON INTERNATIONAL INDUSTRIAL DESIGN FAIR (SIIDEF)

Proceeding International Conference

"Act Locally, Design Globally:
Empathy in Local Innovation,
(From Local Insight to Global Impact)"

FACULTY OF VISUAL ARTS
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Greeting Speech from the Rector

Dear Esteemed Readers,

It is with immense pride and pleasure that I present to you this collection of research outputs, published in this distinguished Book Chapter as part of the *Sewon International Industrial Design Fair (SIIDEF) 2024*. The theme for this year, *"Act Locally, Design Globally: Empathy in Local Innovation,"* is a powerful reminder of how our local insights, traditions, and challenges can shape and inspire global innovations. This publication, much like SIIDEF itself, serves as a bridge between our local heritage and the broader global stage.

At Institut Seni Indonesia Yogyakarta, we have always championed the importance of research as a means to drive both academic progress and social impact. This Book Chapter is a testament to the dedication of our scholars who have worked tirelessly to ensure that their research not only addresses local needs but also resonates with global aspirations. The synergy between empathy and innovation, as explored in these works, will undoubtedly influence both academic discourse and practical applications.

As we continue to foster an environment of intellectual growth and creativity, it is my hope that this compilation will inspire further collaborations and contributions to the field. I extend my deepest gratitude to all who have contributed to this volume and to the SIIDEF 2024 initiative. Together, we are shaping a future where local knowledge has global resonance.

Warmest regards,
Rector of Institut Seni Indonesia Yogyakarta

Dr. Irwandi, M.Sn.

Greeting Speech from the Dean

Dear Scholars, Professionals, and Innovators,

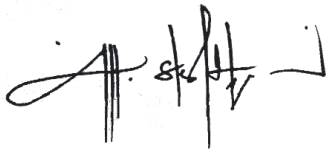
It is with great honor that I introduce this Book Chapter, published as part of the *Sewon International Industrial Design Fair (SIIDEF) 2024*. Under the inspiring theme *"Act Locally, Design Globally: Empathy in Local Innovation,"* this publication represents the very essence of our commitment to fostering innovation that is grounded in local knowledge yet impactful on a global scale.

The research featured in this volume reflects the faculty's dedication to understanding the unique challenges and opportunities presented by our local communities. These studies explore how empathy, as a key component of design thinking, can bridge the gap between local needs and global solutions. By doing so, we reaffirm our belief that design is not only about aesthetics or functionality but about creating solutions that respond to human emotions, values, and cultural contexts.

As the Dean of Faculty Visual Arts and Design, I am incredibly proud of the rigorous research efforts put forth by our scholars. Their work embodies the spirit of SIIDEF 2024, where local insights meet global impact, transforming the way we think about design and innovation. I sincerely hope this book will inspire more research, dialogue, and creativity in our ever-evolving world.

Thank you to all who contributed to this extraordinary endeavor.

Sincerely,
Dean of Faculty Visual Arts and Design



Muhamad Sholahuddin S.Sn., M.T.

Greeting Speech from the Head of Study Program

Dear Colleagues, Scholars, and Enthusiasts,

It is my great pleasure to introduce this Book Chapter, an integral part of the *Sewon International Industrial Design Fair (SIIDEF) 2024*, where the theme *"Act Locally, Design Globally: Empathy in Local Innovation"* takes center stage. This theme captures the very spirit of the research presented in these pages, where local wisdom, craftsmanship, and resources are harnessed to generate innovative solutions with far-reaching global impacts.

In the Product Design Study Program, we have long believed that local culture and traditions offer a wealth of insights that can inform cutting-edge research and design. This Book Chapter reflects our commitment to promoting design solutions that are not only creative and functional but also empathetic and deeply connected to the communities they serve. By understanding and empathizing with local needs, we can create designs that transcend borders and foster a more interconnected and sustainable world.

The work showcased here stands as a testament to our researchers' ability to balance local sensitivity with global ambition. I am proud to see how our study program has contributed to this international dialogue and I hope this book serves as a platform for future collaborations and innovation.

Best regards,
Head of Product Design Study Program

Endro Tri Susanto, M.Sn.

Greeting Speech from the Chief of Committee

Dear Esteemed Readers,

On behalf of the organizing committee, I am delighted to present this Book Chapter, a significant part of *Sewon International Industrial Design Fair (SIIDEF) 2024*. This year's theme, *"Act Locally, Design Globally: Empathy in Local Innovation,"* resonates deeply with the research collected in this volume. The theme encapsulates the essence of the work conducted by our contributors, who have sought to harness local knowledge and empathetic design thinking to create solutions that are both meaningful and globally relevant.

At its core, SIIDEF 2024 celebrates the idea that innovation is most powerful when it arises from an understanding of local contexts, needs, and challenges. The research in this Book Chapter embodies this principle, offering fresh perspectives on how local insights can inspire global change. Whether through sustainable materials, culturally informed designs, or human-centered approaches, each contribution here reflects the spirit of empathy and innovation.

I am particularly proud to highlight that the authors featured in this publication hail from Indonesia, Malaysia, and Germany, bringing together a diverse array of perspectives and expertise. This international collaboration is a testament to the shared values and vision that SIIDEF 2024 promotes. I extend my deepest appreciation to the authors, researchers, and all contributors for their hard work and commitment. May this publication serve not only as a repository of knowledge but also as a source of inspiration for scholars and designers around the world.

With sincere thanks,
Chief of SIIDEF 2024

Nor Jayadi, M.Sn.

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A FOLKLORE NARRATIVE-DRIVEN OF MAT CINCANG DOLL DESIGN

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Abstract

This paper seeks to demonstrate the synergy between local folklore and innovative promotional design strategies that can create a sustainable cultural landscape of Langkawi, Malaysia. Despite the potential of folklore, there are significant gaps in the current promotional products that fail to capture the essence of these stories and their geographical context. Identifying these gaps involves understanding the unique characteristics of the creative economy, which thrives on storytelling, cultural authenticity, and community engagement. Semiotics analyses were done to identify key elements of the story that resonate with both locals and tourists. The character's traits, such as bravery, wisdom, and connection to the natural landscape, were emphasized to ensure that the doll reflects the cultural significance of the legend. The design of the doll incorporated traditional attire and integrating audio technology features that are representative of the local culture, making it visually appealing and culturally authentic and allows it to narrate the story of Mat Chincang and share interesting facts about Langkawi's geography and heritage. The development of the Mat Chincang talking doll as a rich cultural heritage of Langkawi promotional product is a strategic initiative that combines cultural storytelling, interactive technology, and community engagement.

Key words: innovative promotional design strategies, Mat Chincang local folklore, semiotics

INTRODUCTION

Langkawi is the land of myth and legends. It's beautiful natural landscape and attractions come with stories of mythical beings and magic. Today as an UNESCO Global Geopark, Langkawi has bio-geo stories to tell (https://www.naturallylangkawi.my) Langkawi was rich with various legends and mythologies, which can be categorized into different types. Some involve supernatural elements, blending imagination and mysticism that transcend reality. Additionally, there are numerous tales about strange creatures, as well as stories related to the natural formation of caves, hills, and mountains. These mythical and natural phenomena form the historical background of Langkawi. (Windsted, 1936)

The legends of Langkawi Island are deeply intertwined with its natural landscape, particularly through stories linked to supernatural occurrences and remarkable natural formations. Among these are the tales of Gedembai and Telaga Tujuh (Seven Wells), both of which are considered extraordinary phenomena. Gedembai, a figure believed to possess supernatural powers, was said to have the ability to transform objects and beings. The Seven Wells, on the other hand, is a legendary site where fairies were believed to bathe. (Azhari; 1995; Ismail, 2000; Halimi 2006)

In addition to these mystical narratives, Langkawi's folklore also includes legendary creatures such as Garuda, a massive mythical bird, and Buaya Putih, a white crocodile that symbolizes power and mystery. The island's caves are similarly steeped in legend. For example, Gua Langsuir (Cave of the Sirens), Gua Bukit Putih (White Hill Cave), and Gua Cerita (Cave of Stories) are all said to be sites of strange and otherworldly events, each with its own unique mythology. Beyond the legends tied to strange occurrences, animals, and caves, there are also myths centered on human figures, believed to be directly connected to the formation of Langkawi's hills and mountains. The stories of Mat Raya, Mat Cincang, and Mat Sawak are particularly significant, as they are linked to the creation of prominent geographical features such as Gunung Raya (Raya Mountain), Gunung Cincang (Cincang Mountain), and Gunung Sawak (Sawak Mountain). Additionally, two notable legends

stand out in Langkawi's historical and cultural memory. The first is the Makam Ajaib (The Magical Tomb), which tells of the extraordinary powers of Tun Jana Khatib, a figure renowned for his greatness. The second is the legend of Mahsuri, arguably Langkawi's most famous tale. Mahsuri was a woman wrongfully accused of adultery and executed, but according to legend, her curse on the island lasted for seven generations. (Wan Soloh, 1977; Augustin, 1977) From the legends discussed, two distinct sets of values emerge which is the positive and negative. The positive qualities embodied by certain characters serve as virtues that should be embraced in daily life, while the negative traits represent behaviors to be avoided.

Positive values foster admirable, praiseworthy, and endearing human qualities, leading to respect and love from others. In contrast, negative values promote harmful attitudes, poor behavior, and invite disdain and contempt which can be learned from the two of the most famous mountains of Gunung Raya, standing 893.9 meters high and Gunung Cincang merely 696.6 meters high. In between Gunung Raya and Gunung Cincang there is a much smaller hill and this one is properly called Bukit Sawak much lower, being only 471 meters high. The literature about Mat Cincang, Mat Raya and Mata Sawak associated with Langkawi, deeply rooted in the island's cultural and mythical heritage.

This story not only explains the formation of key natural features but also carries moral and cultural significance for the people of Langkawi. The clash of Mat Cincang and Mat Raya is one of Langkawi's most enduring legends, encapsulating themes of conflict, destruction, and reconciliation. The tale not only explains the island's geological features but also conveys important moral lessons about the dangers of pride and anger. Over time, this legend has become deeply ingrained in Langkawi's cultural identity, contributing to the island's allure as a place of both natural beauty and rich mythological history.
The impact of the clash is felt in the island's geography, its cultural consciousness, and its role as a tourist destination, where myth and nature intertwine. According to Ismail (2000) legend, Mat Cincang and Mat Raya were two giants who were once close friends. Their families decided to unite through the

marriage of Mat Cincang's son and Mat Raya's daughter. However, during the wedding feast, a bitter quarrel erupted between the two giants. The cause of the dispute varies in different versions of the legend; some say it was because of a misunderstanding, while others say it was due to the behavior of Mat Cincang's son during the event.The cause of the dispute varies in different versions of the legend; some say it was because of a misunderstanding, while others say it was due to the behavior of Mat Cincang's son during the event.

The argument quickly escalated into a violent fight between the two giants. In their rage, they threw huge rocks and objects at each other, causing destruction across the island. Their epic battle is said to have resulted in the formation of several geographical features in Langkawi such as Gunung Cincang (Mount Cincang) was formed where Mat Cincang stood. Gunung Raya (Mount Raya) arose where Mat Raya was positioned, Gunung Sawak (Mount Sawak), a smaller hill, is believed to have been formed by a peacemaker who tried to intervene in the clash. During the battle, a pot of curry was knocked over, spilling onto the land and creating Kuah Town, a major town in Langkawi (the word "kuah" means gravy in Malay, Figure 1.)

Figure 1. The Geographical And Landmarks Of The Clash Between Two Friends. Source: langkawigeopark.com.my, 2017.

In folklore and mythology, this moral duality is often central to the narrative, reflecting broader cultural teachings.

Good traits such as courage, loyalty, and integrity are championed, while deceit, greed, and betrayal are condemned. In the legend of of Mat Raya and Mat Cincang, associated with the island's natural formations, represent the cultural importance of harmony and conflict resolution, as their legendary feud ends in reconciliation and a reminder of the value of peace over discord. These narratives reflect universal moral lessons that transcend time, offering guidance on human behavior and ethics.

Myths and legends can be used to draw tourists either as main or additional attractions, provide understanding into local history and values and be adopted to attract Western tourists due to the popularity of dark tourism market. (Abdul Razak & Ibrahim, 2017) The utilisation of myths and legends can create a mystic image and offer something extraordinary for potentials tourists to visit. In order to preserve the stories of myth and legends, Lagenda Langkawi was built in 1996, the combination of monumental stone sculptures and a sprawling garden evokes the myths and legends it was designed to commemorate but the lack of upkeep appears to have tarnished that original splendor. The important point about how preservation is key to maintaining not just the physical elements of a historical or cultural site, but also the stories and meanings attached to them. Without proper care, the legends themselves risk fading into obscurity along with the park.

As mentioned by Abdul Razak & Ibrahim (2017), in addition to marketing, the development of tourism products associated with myths and legends in Langkawi as promoting image relating to mythological and legendary tales is not sufficient to attract tourists motivated by these attributes. This effort should be supplemented by tourism products and attractions that inspired by myths and legends. The richness of Langkawi's mythology not only highlights its cultural history but also reflects the islanders' reverence for the natural world. From supernatural beings to mysterious caves and legendary animals, these stories also hold deeper symbolic meanings, reflecting the island's cultural values and its historical connection to natural fotmations. In other literature, Langkawai is often described as a "mythical island", where folk lore has been passed down

through generations, reinforcing its identity as a place where the mystical and natural worlds converge. These legends contribute to Langkawi's reputation as a cultural and historical treasure, attracting both scholars and tourists interested in its mythical past.

Therefore, the aim of this paper is to explore the use of stories as a concept to guide the design of tourism products such as doll as a medium to convey the legend of Mat Cincang as a case study. The doll concept depicts the character of Mat Cincang to be targeted for toy collectible market and dark tourism tourists. With the question of "How Mat Cincang doll can be created through story telling of myth and legend?" and "Why is it important to design a doll as culture promotional product?"

RESEARCH METHODS

The design of the Mat Cincang doll employed two key methodological approaches: semiotic analysis and brand-style DNA analysis. Semiotics, which focuses on the interpretation of signs and symbols, is particularly well-suited for analyzing and synthesizing the aesthetic components of a product, allowing designers to embed deeper cultural meanings into visual forms. Saussure (1916), as cited by Cobley and Jansz (1998), identified the mutually inclusive relationship between the *signifier* (the form of a sign) and the *signified* (the concept it represents). In design, specific aesthetic elements such as color, texture, and shape serve as aesthetic signifiers that communicate the character and expression of a design, both discretely and collectively.

Barthes' (1972) model of *denotation* and *connotation* further extends this framework by distinguishing between the literal meaning (denotation) and the cultural or symbolic meaning (connotation) of design elements. Crow (1993) and Aaker (1996) applied this model to design style, showing how it helps to decode the layers of meaning embedded within aesthetic forms. These theoretical insights guided the analysis of the Mat Cincang doll, where visual elements such as color choices (earthy tones to reflect the natural landscape), textures (rock-like surfaces to echo the geological features of Mat

Cincang), and shapes (sharp, angular forms to symbolize the mountain's strength) were carefully selected to convey the myth's narrative and personality traits.

Brand-style DNA analysis, as outlined by Kapferer (2008), was used to ensure that the design remained consistent with a cohesive brand identity. This approach emphasizes the unique, intrinsic qualities that make a brand distinct. In the context of the Mat Cincang doll, the DNA of the design was crafted to reflect not only the mythological roots of the character but also to align with the broader cultural and tourism branding strategies of Langkawi. The structured application of both semiotic and brand-style DNA methodologies allowed for the creation of a doll that embodies the cultural symbolism of the Mat Cincang legend while maintaining a distinctive and marketable brand identity.

Moreover, the use of semiotics and brand-style DNA in product design is not only limited to cultural products. Krippendorff (2006) suggests that the meanings and interpretations people associate with objects are central to the success of design. Similarly, Papanek (1985) highlights that design for cultural products, in particular, requires sensitivity to both aesthetic and symbolic dimensions, making semiotics a vital tool for achieving deeper cultural resonance. These frameworks ensure that the Mat Cincang doll does more than act as a souvenir—it serves as a cultural intermediary, carrying the narrative weight of Langkawi's myths into the global tourism marketplace.

Semiotics, the study of signs and symbols, plays a key role in ensuring that the design of the doll communicates the intended meaning of the Mat Cincang myth. This involves:

1. Identify the Signs and Symbols: In semiotic analysis, signs are anything that conveys meaning, and they are composed of two parts: the *signifier* (the form which the sign takes) and the *signified* (the concept it represents). We begin with literature search and analysis as in Table1 and used moodboard as in Figure 2 and Figure 3 to visually represent the key symbols and representations of the Mat Cincang

myth and with the moodboards, the Brand-style DNA analysis was tabulated as in Table 2.

Table 1- Analysis of semiotics

Element	Signifier	Signified/Connotation
Mat Cincang	Mountain	Power, eternal presence, punishment
Feud with Mat Raya	Conflict	Rivalry, pride, consequences of anger
Transformation into stone	Stone, immovability	Moral permanence, the weight of punishment
Cultural context	Malay folklore	Respect for nature, balance, and moral consequences

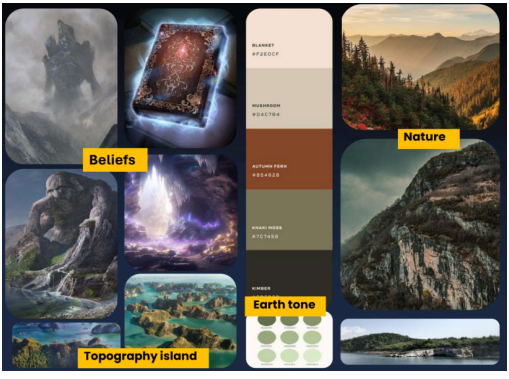

Figure 2. Moodboard represents cultural and mythical.

Figure 3. Moodboard represents feud between Mat Cincang and Mat Raya and Mat Sawak as the peace maker.

Table 2- Analysis of Brand-style DNA

DNA Component	DNA Description
Core Values	Tradition, Nature, Sustainability, Mythology
Visual Identity	Earthy tones (browns, greens, greys), angular shapes to reflect the mountain, gold accents for mysticism
Tone	Educational, empowering, storytelling
Voice	Mystical, cultural, authentic
Brand Personality	Mythical, cultural ambassador, timeless, sustainable
Emotional Appeal	Nostalgia for locals, curiosity for tourists, connection to nature

2. **Denotation (Literal Representation)**

Denotation is the literal or primary meaning of a sign. The denotation of Mat Chincang is simply a character from a myth who becomes a mountain.The analysis of Mat Cincang characters and clothing was done to reinforcing a connection to the myth as in Figure 4 and Figure 5.

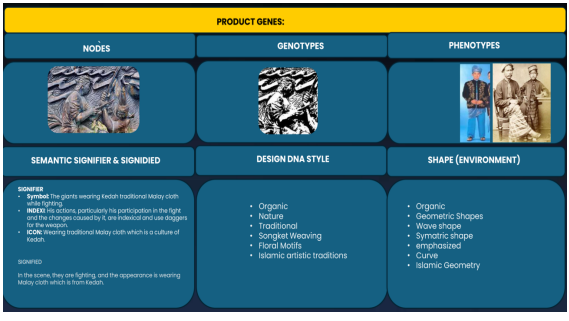

Figure 4. The **Denotation** analysis of Mat Cincang characters.

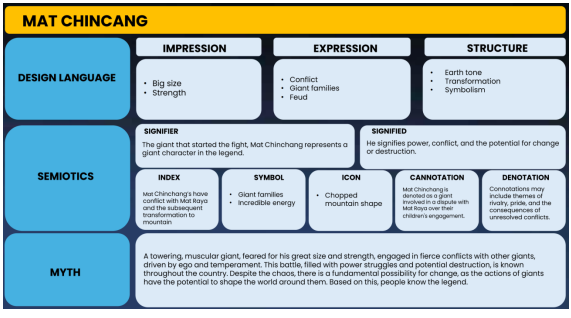

Figure 5. The **Denotation** analysis of Mat Cincang styles clothing from the era of the legend.

From the analyses above it can be concluded that;

i. The Mountain: Mat Chincang is transformed into a mountain after his quarrel. Mountains often symbolize permanence, immovability, and strength.
ii. The Conflict: The feud between Mat Chincang and Mat Raya represents larger social dynamics and themes like pride, power, and rivalry.
iii. Transformation into Stone: The transformation of Mat Chincang into a mountain can be interpreted as a symbolic act of punishment, solidification of moral consequences, or the permanence of certain legendary figures in culture.

From the narratives above, the story of Mat Cincang, Mat Raya and Mat Sawak is significant in the Malay folklore especially in Langkawi. The myth highlights the role of stories in maintaining cultural identity and transmitting values. These narratives carry lessons that shape collective memory and influence the behaviors and beliefs of a community. In a globalized world, such myths contribute to the preservation of local traditions and offer unique insights into the ways different cultures address universal human issues.

The myth highlights the destructive nature of unresolved disputes. In failing to reconcile or compromise, the giants cause damage not only to themselves but also to the community around them. This narrative reinforces the need for dialogue, forgiveness, and the importance of controlling emotions in moments of tension. Through the downfall of the giants, the story teaches humility. It suggests that understanding one's limitations and respecting others' perspectives is crucial for maintaining harmony in relationships and society. In a broader philosophical context, the myth can be interpreted as a cautionary tale about the perils of ego-driven actions.

The myth teaches that human actions, whether positive or negative, leave an imprint on the environment. It underscores the connection between people and the natural world, with nature often reflecting or responding to human behavior. These lessons are relevant across time and cultures. From the dangers of pride and conflict to the importance of humility and social

harmony, these stories carry rich moral, philosophical, and environmental teachings. Moreover, the myth plays an essential role in preserving cultural identity and heritage, illustrating the power of storytelling in shaping values and worldviews across generations. It showed that Mat Cincang, Mat Raya and Mat Sawak is important to be highlighted. However, there was vague visual representation of Mat Cincang from literature search. Therefore, benchmarking as in Figure 6, was done to understand the character through selected archetypes which to provide a deeper insight into the myth's character of powerful and cold, dignity and proud persons. Three character archetypes were chosen; the hulk to symbolize the powerful giant and hot tempered, Rudy Agent Ali to symbolize a cold character. Rudy agent Ali is a character in famous Malaysian animation series that was chosen to portray the futuristic contemporary scenario of Malaysia.

Figure 6. The **Benchmarking of archetypes character.**

Figure 7. The **development of posture.**

Series of sketches for concept development as in Figure 7, 8 and 9 were visualized based on facial and posture features of the archetypes character. Further the detail and exploration as in Figure 10, was visualized based on the Hulk and Rudy Agent Ali with different clothing. Figure 11 is another detail and exploration of using body type 3 from Figure 9 with the combination the "orang lama Langkawi " clothing which was chosen as the final doll design concept.

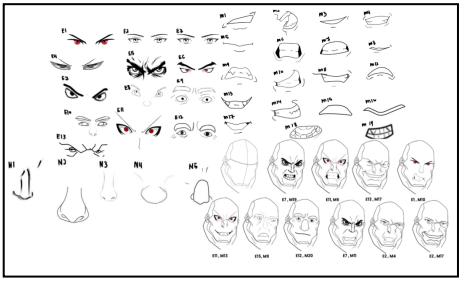

Figure 8. The **development of facial expression.**

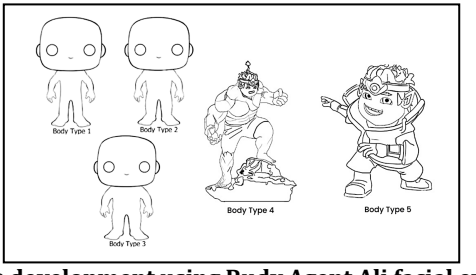

Figure 9. The **development using Rudy Agent Ali facial expression.**

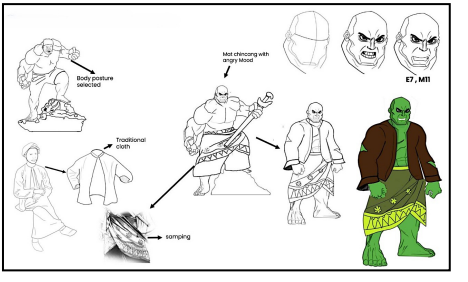

Figure 10. The **development using the Hulk facial expression. with clothing and colors.**

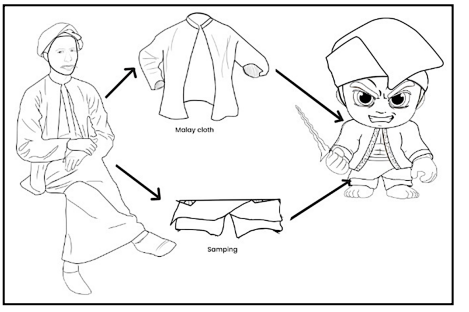

Figure 11. The **development using Rudy Agent Ali facial expression with clothing and colors.**

Figure 12 illustrates the final doll design of Mat Cincang, which fulfiled the croteria of Mat Cincang characters which is leadership and strenght, wisdom, hot-tempered, vengence and pride.

Figure 12. The **final concept of Mat Cincang doll.**

DISCUSSION

The aim of this paper is to explore how stories, particularly myths and legends, can guide the design of tourism products, using the Mat Cincang doll as a case study. The research addresses two core questions: *How can a Mat Cincang doll be created through storytelling of myths and legends?* and *Why is it important to design a doll as a cultural promotional product?* These questions highlight the role of storytelling in shaping the visual and symbolic elements of the doll, transforming it into a medium for cultural transmission. The adaptation of semiotic principles and Brand-style DNA has proven to be an essential tool in conveying both explicit and implicit messages about the personality and narrative of Mat Cincang, offering a structured framework to decode the rich mythology behind the figure.

Semiotic analysis in this context enabled the researcher to interpret key narrative elementssuch as color, shape, texture, and form—to create a design that signifies Mat Cincang's mythological identity. This method parallels similar works by Stephen (1993), who demonstrated how dolls serve as cultural intermediaries, reflecting societal values such as gender roles and family structures. Likewise, Amoian and Motlaq (2022) used Roland Barthes' semiotic theory to analyze the Barbie doll myth, illustrating how even contemporary toys carry underlying cultural messages.

What is essential in these examples, and particularly relevant to the Mat Cincang doll, is the awareness of the cultural context of the audience. As Monica Chen (2020), a user experience designer for Barbie, noted, cultural misalignments can occur when Western ideals are imposed on Eastern markets. In the case of Barbie, Chinese consumers did not fully grasp the feminist message behind the doll, instead viewing her as a symbol of beauty rather than empowerment. This underscores the importance of culturally sensitive design when creating products for cultural promotion.

The concept of Brand-style DNA is essential for creating a cohesive and recognizable cultural product. According to Kapferer (2008), Brand DNA refers to the core elements that define a brand's identity, such as values, personality, and visual identity, which remain consistent over time. For the Mat

Cincang doll, the Brand-style DNA should reflect the values and aesthetics of Langkawi's tourism, creating a product that is not only visually appealing but also symbolically aligned with the island's cultural heritage.By incorporating Brand-style DNA into the Mat Cincang doll's design, the product becomes part of the broader narrative of Langkawi as a tourist destination.

The doll's design, with its natural themes and cultural significance, mirrors the island's branding as a place of natural beauty and rich folklore. The integration of these elements ensures coherence with Langkawi's tourism brand, helping the Mat Cincang doll stand out in the market while remaining true to its cultural roots.This approach is particularly relevant given the growing market for cultural and collectible toys. The Mat Cincang doll, if positioned effectively, could appeal not only to tourists but also to collectors interested in unique, culturally significant products. The alignment of Brand DNA with Langkawi's tourism goals thus enhances the doll's appeal as both a cultural artifact and a desirable collectible item.

The growing market for collectible toys presents a strong opportunity for the Mat Cincang doll as a cultural product. A report by Market Decipher (2023) forecasts that the toy collectibles market will grow to USD 35.3 billion by 2032, driven by factors such as nostalgia, pop culture influences, limited editions, and the rise of e-commerce platforms. The design of Mat Cincang as a collectible doll aligns well with this booming market. By combining local folklore with innovative design strategies, the doll has the potential to bridge the gap in current promotional products, which often fail to fully capture the essence of myths, legends, and their geographical contexts.

However, one of the key challenges is ensuring that the Mat Cincang doll resonates with both local and international consumers. While the doll's design can draw on Langkawi's myths and legends, it must also appeal to the tastes and expectations of a global audience. This requires a careful balance between authenticity and marketability, ensuring that the doll remains true to its cultural origins while also being accessible and desirable to collectors worldwide. Despite the promising prospects, the research acknowledges a significant limitation: the absence of a proof of concept. While the

theoretical framework is robust, further investigation is needed to assess the commercial viability and cultural impact of the Mat Cincang doll. Future research should focus on conducting market testing to evaluate consumer reception, both in Langkawi and globally.

CONCLUSION

This paper has explored the application of semiotics and Brand-style DNA in the Mat Cincang doll design, particularly how visual elements can convey cultural messages and deeper societal meanings. By utilizing semiotic principles such as signifier and signified, denotation, connotation, and codes, the analysis has demonstrated how myths and legends can serve as narrative-driven design strategies for innovative promotional products. The findings contribute to a gap in current research by illustrating how mythological and legendary stories, such as the tale of Mat Cincang, can be effectively translated into a tangible tourism product like a collectible doll using Brand-style DNA.

The integration of application of semiotic principles, alongside Brand-style DNA, creates a framework that ensures the doll not only reflects Langkawi's cultural identity but also aligns with the island's tourism branding. This makes the Mat Cincang doll a powerful tool for cultural transmission for the preservation and promotion of local heritage. The Mat Cincang doll design offers a creative solution to preserving traditional stories, addressing the limitations of current marketing and promotional efforts.

The global market for collectible toys, projected to grow significantly, provides a fertile ground for the Mat Cincang doll to succeed as both a cultural and commercial product. However, the research highlights the importance of balancing cultural authenticity with global marketability to ensure the product resonates with diverse audiences. The absence of a proof of concept is a limitation, suggesting the need for further research in market testing to evaluate the doll's cultural impact and commercial potential. If these challenges are addressed, the Mat Cincang doll could effectively bridge the gap between cultural promotion and global collectible trends.

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FLATPACK CLASSROOM FURNITURE DESIGN 1:10 FOR SPATIAL LEARNING MEDIA FOR ELEMENTARY SCHOOL STUDENT

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Abstract

The design of classrooms in Indonesia currently adheres to government standards. However, varying conditions and situations across different regions result in classrooms with diverse shapes and layouts. This diversity can impact students' understanding and familiarity with their learning environments. This research aims to develop 1:10 scale flatpack classroom furniture designs made from child-friendly materials, featuring components that students can assemble themselves. This product enables students to learn about and recognize the layout of their daily classroom environment through play and simulation, alongside their teachers and peers. The approach involved school site observations and creatives experiments with various classroom furniture designs available in the classrooms. Respondents are 68 students from various State Elementary School in Indonesia, participated in the study. The findings can help school stakeholders provide a comprehensive and spatial learning experience for students.

Key words: flatpack furniture design, spatial learning, elementary school student

INTRODUCTION

Students' understanding of the classroom environment is still very limited, whereas it should play a role in enhancing their interest in learning. Therefore, the implementation of learning

activities at the elementary level requires a conducive atmosphere, both inside the classroom and in the surrounding school environment. A supportive atmosphere is essential for students to learn more effectively and comfortably (Fauziati, 2016). Students experience various spatial elements from the moment they enter through the school gate, pass by the field, walk through the classroom hallway, and enter the classroom, until they sit in their assigned seat. The various things they see within the school environment provide a wealth of information that can be absorbed through the senses, such as school buildings, plants, teachers and friends, as well as the furniture used. Formal education in Indonesia is mostly conducted in a structured manner, either inside or outside the classroom, within a school setting according to a predetermined schedule. The complexity of the learning material provided is adjusted to the student's educational level.

The classroom plays an important role in the learning process, allowing students to acquire knowledge, skills, and attitudes, which are the main goals of education in Indonesia. The function of the classroom is to serve as a place for theoretical learning activities, practical learning that does not require special equipment, or practical activities with specialized tools that are easy to provide (Lampiran Peraturan Menteri Pendidikan Nasional No. 24 Tahun 2007, 2007). The physical conditions standards in elementary classrooms are described as follows: the classroom serves as a space for learning activities, a practice that does not require special equipment or practice with available special tools. The number of classrooms must be equal to the number of study groups. The classroom has a maximum capacity of 28 students. The minimum classroom area-to-student ratio is 2 m2 per student. The minimum classroom area for study groups of less than 15 students is 30 m2. The classroom's minimum width is 5 m. Classrooms should have adequate lighting for reading and allow views of the outside. Classrooms should have adequate doors that can be properly locked when classrooms are not in use so that students and teachers can leave the room immediately in case of danger.

Each classroom is arranged according to these standards to support the students' learning activities so they can be carried out effectively. The proper selection and design of teaching tools and facilities will have a positive impact on improving the quality of student learning (Zainudin et al., 2018). Every classroom is organized according to these standards to facilitate effective student learning activities. The careful selection and design of teaching tools and facilities will positively influence and enhance the quality of students' learning experiences (Satriaji et al., 2020). Every classroom is organized according to these standards to facilitate effective student learning activities. The careful selection and design of teaching tools and facilities will positively influence and enhance the quality of students' learning experiences.

Figure 1. Classroom Configuration of Lebak Gede Elementary School, Sumedang, West Java, Indonesia
Source: Satriaji, 2023.

In the image above (Fig. 1), a configuration of a typical public elementary school classroom in Indonesia can be seen, using the classroom at Lebak Gede Elementary School, Sumedang, West Java, Indonesia as an example. The classroom has several common features, including: (1) A blackboard located at the front of the room as the main orientation for teaching. This front area is also where the teacher delivers instructional material; (2) The teacher's desk and chair are placed at the front of the classroom, usually on the left (or

sometimes the right), to facilitate supervision and classroom management; (3) The students' desks and chairs, made of wood, are positioned in the center of the classroom. Typically, the desks and chairs are arranged in neat rows and columns in a grid format. The design of elementary school chairs encourages children's learning activities in the classroom. (Purwaningrum et al., 2017) ; (4) Each classroom has windows on the left, right, or both sides. These windows also serve as a source of natural light for the classroom. Some classrooms cover the windows with paper to reduce distractions from outside activities; (5) Various other attributes supporting learning are typically placed around the classroom.

The walls often serve as the primary area for displaying classroom materials or learning aids. Posters of Indonesian heroes, multiplication tables, images of traditional houses, and class schedules are commonly found inside the classroom.The development of classroom interior design in Indonesia is shaped by two key factors. First, the modernist paradigm has heavily influenced the organization of classrooms. This approach emphasizes a systematic arrangement, with formal distances between objects, creating a structured relationship between teachers and students.

In this setup, both teacher and student bodies are disciplined to follow the prescribed layout, which is viewed as essential for fostering productivity and enabling scientific progress. Second, the influence of state ideology plays a significant role. The government sees education as a means to instill discipline and ensure obedience among citizens. As a result, schools function not only as places for academic learning but also as institutions that reinforce state power by imparting ideological values alongside scientific knowledge. (Saidi et al., 2023)

What if students were given the opportunity to explore the seating area they use in the classroom? What if they were allowed to simulate activities around their desks? These questions inspired the idea to create this 1:10 scale flat-pack classroom furniture design. Spatial issues can be addressed through various disciplines, one of which is interior design,

which focuses on the relationship between people and the spaces in which they carry out activities. (Demirbas, 2017)

Classrooms, or even the desks and chairs used by students, can have unique identities depending on how students and teachers utilize them. In the realm of interior design, the identity of a space is shaped by the integration of all elements within it, such as the ceiling, walls, floor, furniture, colors, lighting, and more, which are then interpreted in a specific way by the users of that space. This research focuses primarily on the furniture used by students in the classroom, specifically desks and chairs. These items are used daily by students for various activities, both structured and free. In the context of the classroom, design can play a role in facilitating learning activities. The learning stages of students, when related to the design thinking process, include observing, questioning, gathering information, processing information, and communicating ideas. These learning stages will be applied in the form of a simple model design module using cases and objects from the classroom that students encounter daily.

The standards set by the government regarding classrooms and their elements usually do not involve direct discussion with the primary users, namely students and teachers, despite being the main users of the classroom space and its furniture. Currently, there are not many products that assist students in understanding their territory within the classroom. The inability of desks and chairs to accommodate students' activities when using active learning methods has prompted efforts to innovate the design of student desks and chairs. (Zainudin et al., 2018)

As a result, students may feel less connected to the classroom and its furniture. The question that arises is how to enhance students' sense of belonging to the objects present in the school, thereby encouraging them to engage more actively in school activities. Based on this background, this research conducted several questions, namely:

1. How to help students to be familiar with their classroom?
2. What if studentswere given the opportunity to explore their personal area they use in the classroom?

3. What kind of items might student want to keep around their desk?
4. What kind of design can introduce spatial understanding to student in a fun way?

This innovative research aims to enhance students' sensitivity to the classroom through a product design in the form of a 1:10 scale flat-pack furniture model of student desks and chairs, which can serve as a learning aid. Models or prototypes are commonly used by artists, designers, and architects to convey ideas in three-dimensional form, making them easier for others to understand. Flat-pack furniture, also known as ready-to-assemble (RTA) or self-assembly furniture, refers to furniture that is sold in disassembled form and designed to be easily put together by the consumer.

The concept is popular because of its cost-effectiveness, convenience in transportation, and ease of storage. Instead of purchasing a fully assembled piece, customers receive furniture parts, often in a flat box, along with instructions and the necessary hardware. Several furniture components are packaged and provided with instructions on how to assemble them. (Agustiano et al., 2018)

The resulting flat-pack furniture design can create a new activity in the form of a game for arranging the configuration of desks and chairs in the classroom. By fostering design awareness from an early age, it is hoped that this will support and enrich the learning experience within the classroom. The flat-pack design of the desks and chairs takes into account the opportunities for student and teacher involvement in assembling, playing with, and implementing the furniture in real school settings.

RESEARCH METHODS

This research is conducted through a creative-based approach aligned with the fields of fine arts and design. The methods used include observation and creative experimentation, directly involving users to produce a suitable product. The resulting model will indirectly train students'

spatial abilities in arranging and assembling an object according to instructions, as well as their problem-solving skills. This innovative research is part of a social-based study aimed at addressing contextual issues within the community. (Wenzel & Babbie, 1994) The spatial elements highlighted in this innovative research are the desks and chairs used by students in the classroom. Several stages are undertaken to identify the forms and subsequently produce a product that is suitable for training and introducing students to the sensitivity and awareness of the furniture and classroom they use daily.

1. Data collecting and side visit

   The data collected includes the characteristics of children, the types of furniture used in schools, safe plastic materials for children, and various designs of classroom models. This data was gathered through direct surveys in the field as well as references from standard books, journals, and digital media.

   The chosen location is Lebak Gede Public Elementary School in Tanjungsari, Sumedang, West Java. This location was selected because it is a public school with appealing potential in terms of both location and resources. The students involved will be those in grades 4 to 6, considering their maturity in cognitive abilities.

2. Criteria and Concept

   The criteria for the model design are established by considering several aspects, particularly the characteristics and behaviors of children as users. Another important consideration is the clarity of information regarding the shapes of components and the assembly process for elementary school-aged children.

   The selection and use of materials that are safe and non-toxic are also prioritized, along with practical factors for packaging and mobility. Additionally, it is crucial that the resulting design incorporates elements of challenge and entertainment for children, given their high curiosity. More detailed criteria can be found in the table below. (Table 1).

Table 1 – Design Criteria and Consideration

Criteria	Description	Information
Dimension	The product is designed to be easily portable and packaged. It has dimensions that are neither too large nor too small, making it practical for use	The dimensions of the flat-pack furniture design are kept compact so that it can be assembled on each student's desk. 10,5 x 14,8 x 0,3 cm (A6) Postcard size
Shape and form	The components of the student desks and chairs are arranged in sheets.	The components of the desks and chairs can be assembled from 2D into a 3D shape of furniture at scale 1:10
System	Using a RTA or flat-pack system, the components can be assembled into the form of student desks and chairs	The product can be assembled by students into the desks and chairs they commonly use in the classroom
Material	The materials are child-friendly, as they will be used by elementary school students.	The prototype is created using 3D printing methods with PLA+ filament, which is child-friendly because it is non-toxic and safe for food contact
Color	Bright colors are used, aligning with the characteristics of children	The colors currently used are limited to those available based on the filament.

The concept behind this design is to create a product that can be self-assembled (DIY) by students and teachers, while also inspiring students to be creative. The assembly process will enhance students' motor skills as they practice hard skills such as cutting, gluing, attaching, and composing objects.

3. Ideation
   The main forms to be constructed are desks and chairs for elementary schools. Various models and shapes of desks and chairs used at the elementary level have been collected. The most suitable and representative designs are selected to be sketched in a manual version, illustrating the components that make up the product. The results of this ideation process will serve as the foundation for the modeling process.

4. Modelling
   The modeling process uses SketchUp software to translate the components of the selected table and chair model. The modeling process uses a 1:10 scale which means that the

product will be 10 times smaller than the actual object.

5. Prototyping
   The prototype is created using a 3D printer, specifically the Creality K1, which won the Red Dot Award 2024 in the field of industrial design. The expected results must be highly precise according to the design, as the assembly system is taken into account. The filament material used is polylactic acid (PLA), which is known for its strength, durability, and eco-friendliness.

6. Assembly Test
   Assembly testing is conducted to determine the precision level of the flat-pack furniture design module concerning the joints of each component. At this stage, we can also assess how long the assembly takes.

RESULT

The forms of desks and chairs used in elementary schools today are quite diverse, including single student desk and chair sets, models designed for two students, and more modern designs (Fig. 2). The primary materials for these desks and chairs are mostly made of wood and aluminum. The wood commonly used is Meranti, which appears sturdier but is heavier compared to fabricated aluminum desks and chairs, which are lighter but may seem more fragile when handled.

Figure 2. Several models of student desks and chairs used in elementary schools include the single-seater model (left), the long bench model (middle), and the aluminum model (right)
Source: Satriaji, 2024.

The desks and chairs used and translated into a 1:10 scale model in this research are those made of wood. The reason for selecting this model is not only because it has a simpler design, but also because it is the most commonly used type in public elementary schools throughout Indonesia (Fig. 3).

Figure 3. Desks and chairs for students are made from meranti wood.
Source: https://e-katalog.lkpp.go.id/

The chosen design is a set of desks and chairs for the classroom with a capacity for one student, ensuring that each student has their own desk and chair. The features of these desks and chairs are simple yet functional. The student chair has a rigid and upright design, with a backrest that supports the student during the learning process. The backrest is also often used by students to hang their bags. Each chair's four legs are equipped with stabilizing structures to maintain its shape even when weight is applied. The underside of the desk includes a drawer for storing bags and stationery. The standard dimensions of the desks and chairs can be found in the table below. (Table 2)

The selected desks and chairs are then broken down into separate components. The classroom chair model is divided into five components: the backrest and rear legs, front legs, seat, right leg connector structure, and left leg connector structure. The seat and backrest sections feature a grid of holes measuring 3.5 x 3.5 mm. These square holes serve to integrate other objects into the product or for assembling the flat-pack furniture design of the desks and chairs onto a specific base. The seat has 16 holes, while the backrest has only 4 holes.

Table 2 – Student Chair and Desk Dimension (Diknas, 2009)

Furniture	Dimension (cm)		
	Length	Width	Height
Single Desk	60	55	65-71
Double Desk	120	55	67-71
Chair	38	38	40-44
Bench	120	38	40-44

The desk model consists of six components: the front legs, rear legs, left side cover, right side cover, tabletop, and drawer cover. The tabletop features holes to facilitate the storage of items on the model. Each component is configured into a frame sized like a postcard. The configuration of all the desk and chair components requires three sheets of this frame (Fig. 4). The postcard size is chosen for easy transport and could also serve as a souvenir product for the school. However, as of this writing, considerations regarding effective packaging have not yet been fully developed.

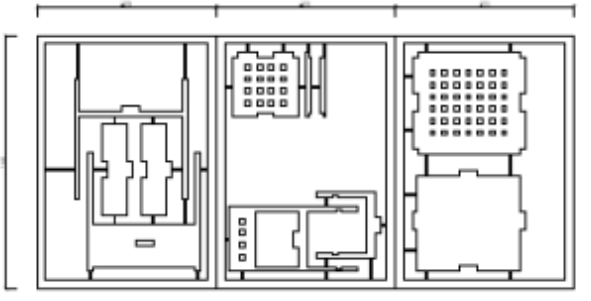

Figure 4. Table and chair component
Source: https://e-katalog.lkpp.go.id/

Based on the configuration above, it can be observed that there are still many empty spaces between the components. This condition presents opportunities to add other objects in the surrounding areas. Before incorporating items into the gaps between the products, students are asked what they feel is still

lacking. Students are given the following question: "Please write down 3-5 objects you would like to have in the classroom" (Fig. 5).

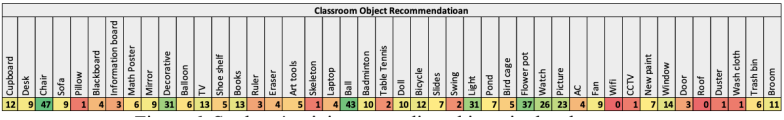

Figure 5. Students' opinions regarding objects in the classroom.

There were 63 elementary school students who responded to this question. From the responses, several objects that students desired to have in the classroom were identified, including chairs (47 votes), balls (43 votes), lamps (31 votes), and flower pots. These results will be used as a basis for selecting objects chosen by students as supportive equipment within the classroom. For the final design, we included some student's choices, as examples, ball, table lamp, umbrella, aquarium, tumbler, mug, shoes, etc (Fig. 6).

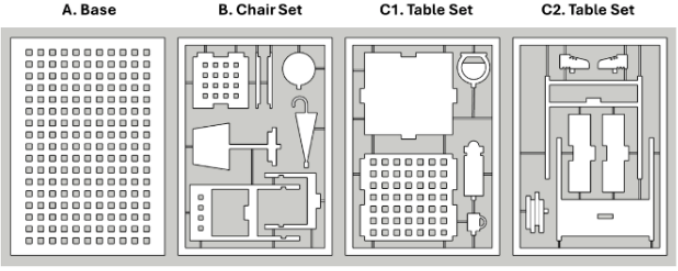

Figure 6. The modelling composition with all the accessories included.

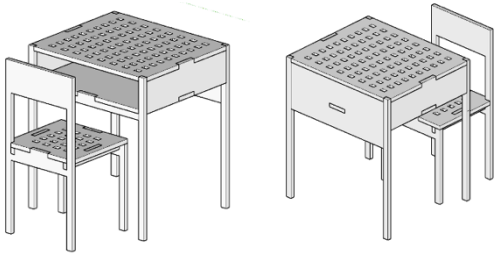

Figure 7. Modeling is created using software by combining the components.

The components are then assembled and simulated into the three-dimensional forms of desks and chairs (Fig. 8). The initial expectation was that the assembly process would not require glue; however, it turned out that the sizes were too large, making it difficult to assemble the components properly.

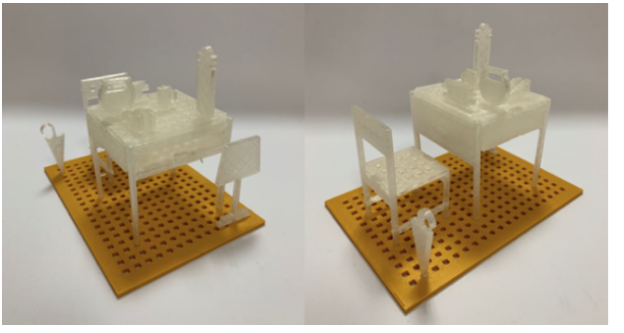

Figure 8. The assembled product model.

To make it more colorful, several colors can be combined together according to the student's preferences. As examples, clear color filament can be combined with yellow, red, green or blue to make it more personal.

DISCUSSION

Based on the research findings and the products developed, several points can be concluded as follows:

a. The classrooms of public elementary schools in Indonesia have established standards set by the government; however, their implementation varies greatly. These standards seem inadequate to accommodate the characteristics of students, who have a high level of curiosity. Students appear to be compelled to use the classroom and their seating area as they are, without opportunities for personalizing their territory.
b. The flat-pack design of the desks and chairs at a 1:10 scale is primarily intended to enhance students' understanding of space, including their territory within the classroom, particularly the area around their seats. This design also provides opportunities for students to be creative with

various accessories provided, which they can then compare and discuss with friends, teachers, or parents.

c. The flat-pack classroom furniture design still has potential for further development according to the needs of each school, addressing contextual issues to make it more accessible and understandable for children.

CONCLUSION

This flat-pack furniture design represents an effort to create a product that can be utilized by both students and teachers in the classroom. For students, this design provides information and experiences about the area they occupy during their school years. Additionally, it helps cultivate students' sensitivity to shapes by observing the existing components.

Creativity, courage, and freedom of expression are also nurtured through the assembly process. For teachers, this design can serve as an introductory activity at the beginning of the school year, where each student is asked to assemble their furniture and then showcase it to their classmates. The hope is that this will enhance students' understanding of space.

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DESIGNING FOR ADOPTION: PARTICIPATORY APPROACHES TO WASTE PROCESSING SOLUTIONS IN BEKASI, INDONESIA

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Abstract

This article examines the gap between designers and communities in participatory design practices, using community-adoptable waste processing as a case study. The research was conducted in Mekarmukti and Tanjungbaru, Bekasi, West Java. Critical motivational factors within the community, such as economic benefits and pride, influenced the acceptance of proposed solutions while constraining them to options aligned with local preferences. Designers formulated solutions that sought to accommodate these preferences. This qualitative study employed a participatory action research approach, integrating material exploration methods during the implementation phase. Laboratory-scale experiments were conducted prior to the broader application of the findings. As of this writing, the preparation phase is on going. The results suggest that waste processing solutions are more readily accepted when they align with the community's technical preferences, do not require substantial investment, and avoid significant disruptions to daily routines. A process model is proposed that emphasizes solutions minimizing additional work and behavioral changes. The artifact model remains under development.

Key words: participatory design, waste management, designer, community, gaps

INTRODUCTION

Waste management in communities is not just a physical issue but also involves complex social, cultural, and environmental dimensions. A key challenge lies in the differing perceptions of what constitutes a clean or dirty environment, as well as varying sensitivities to waste-related disturbances. While raising awareness is an important first step, understanding the community's actual waste management practices is equally crucial, as these are often shaped by underlying drivers within the community. Designers can tap into this local knowledge as a valuable resource for crafting appropriate solutions.

A shared understanding between communities and designers can be fostered through participatory methods, which help identify and address community needs. (Jokhu and Kutay, 2020) By engaging in participatory design, designers can collaborate with communities to develop solutions that are sustainable, accessible, and feasible for adoption. However, the success of participatory design hinges on the depth of community involvement. Active engagement is essential for uncovering key issues and opportunities within the community. (Jagtap, 2018) as building empathy through direct experience offers a more comprehensive and accurate perspective.

Community-level waste management has traditionally centered on addressing waste after it has been generated, as communities have no control over the types and quantities of consumer goods produced. (Pongrácz, 2002) However, communities can play an active role in managing waste collection, sorting, and processing on a small scale. (Cai et al., 2021)

Collective efforts in waste management have the potential for a larger impact, particularly when active participation is encouraged. Despite awareness of the harmful effects of improper waste management, many communities face limited options. (Nxumalo et al., 2020) A lack of knowledge about effective waste management remains widespread in many Indonesian cities (Brotosusilo & Handayani, 2020), emphasizing the need for drivers that support community involvement, such as perceptions, behaviors, and tangible benefits. (Farida et al.,

2024; Jiang et al., 2021; Suryawan & Lee, 2023) Skepticism towards waste management initiatives often arises when these efforts, conducted by individuals or small groups, appear to have limited impact. (Budihardjo et al., 2022) Enhancing awareness of the social and economic benefits of community-based waste management could therefore strengthen sustainability. (Oyinlola et al., 2018)

Such community-based approaches can help reduce government expenditure on waste collection, transportation, and disposal, while also extending the lifespan of landfills. However, social conditions and available infrastructure significantly influence how communities handle waste, shaped by both perceptions and behaviors (Jiang et al., 2021) as well as the adequacy of public infrastructure and services. (Cai et al., 2021)

Waste management through recycling is particularly relevant to social dynamics. (Huysman et al., 2015) However, recycling is more closely tied to cultural issues than to social, economic, or environmental factors, as the current production cycle fosters a throwaway culture. (Bridgens et al., 2018) The approach to recycling differs between community-scale and industrial-scale operations, with different environments and community types requiring distinct models. Closed-loop recycling, which involves material purification, is unsuitable for community-scale initiatives due to the high investment costs. (Eriksen et al., 2019)

In contrast, open-loop recycling is more feasible at the community level, as it produces materials that, although of lower quality, have broader applicability. (La Rosa et al., 2021) However, closed-loop recycling can be practical in specific settings, such as the recycling of surgical instrument packaging in hospitals. (Van Straten et al., 2021) Recycling schemes often experience diminishing environmental benefits when their processes become more costly than disposal alternatives. (Huysveld et al., 2019) Key factors influencing recycling-based waste management include economics, social acceptance, technology, market dynamics, and public awareness. (Duan et al., 2021) Design can play a critical role in overcoming these limitations through material-driven approaches, where new

products are developed based on available recycled materials (Ragaert et al., 2020), ensuring that the product value remains comparable to that of newly manufactured goods. (Polyportis et al., 2022)

Based on the established reasoning, it is assumed that community-based waste management through design cannot be approached in a top-down manner. While designers can propose product development, decisions must be grounded in the community's technical preferences and aligned with the specific community context. (Rahardiani et al., 2024) Design can ensure that solutions maintain value comparable to new products. (Polyportis et al., 2022; Rahardiani et al., 2024)

The case study from Mekarmukti and Tanjungbaru, Bekasi, illustrates the crucial role of the community as co-designers in shaping waste management solutions. The differing frameworks between community and designers necessitate a bottom-up approach from designers. Highlighting this approach is essential, as it adds a significant dimension to the research, beyond the more commonly discussed outcomes or workshop processes found in similar studies.

METHODS

This study employs participatory action design, grounded in the perspective that the knowledge of community issues and needs resides within the community itself. (Jokhu & Kutay, 2020; Müller, 2021) Engagement with the community and an in-depth exploration of their waste management practices were conducted from November 2021 to May 2024.

The findings led to the development of a conceptual model for identifying key factors in collective community-based waste management. Data collection involved in-depth interviews with village heads, experts, recycling center managers, and waste bank operators, complemented by discussions with community members and supported by questionnaires.

Field observations and visual documentation were used to understand the geographical characteristics of the community's living environment. Data were gathered from two villages, three hamlets, two waste banks, and one recycling center. Key informants assisted throughout the process, facilitating access

to the community, especially in informal settings. Reflections from each activity were used to continuously inform subsequent activities. (Schön, 2017) To address subjectivity and bias, discussions and workshops were conducted as part of a triangulation effort.

Inspiration Session

This study presents a structured mapping of dominant driving factors to aid in analysis. The mapping is based on Bandura's social cognitive theory (McAlister et al., 2008), which helps establish general criteria. According to the Theory of Planned Behavior (Montano & Kasprzyk, 2008), the driving factors for waste management can be categorized into internal and external factors. Operationally, the collected data were analyzed using diagrams, as illustrated in Figure 1.

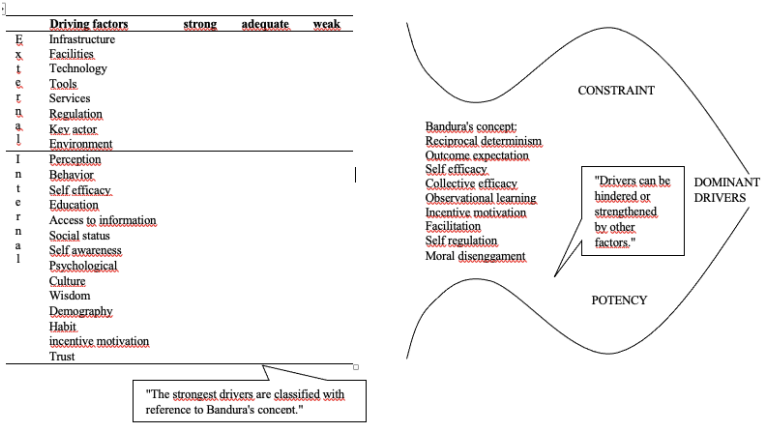

Figure 1. Operational scheme of analysis
Source: developed by authors, 2023.

Ideation Session

In October 2023, this session engaged three experts from both practitioner and academic backgrounds to identify the most promising participatory design actions. The practitioners included a Specialist in Village Economic Development from the Village Development and Empowerment Program, Bekasi, and a Design Thinking Practitioner from the Ministry of Education of

the Republic of Indonesia.

The academic expert was a lecturer in Product Design with a focus on waste management. The session illuminated the interconnections between four key issues: waste management practices, types of waste generated, waste disposal locations, and existing facilities. These issues were mapped diagrammatically, as shown in Figure 2.

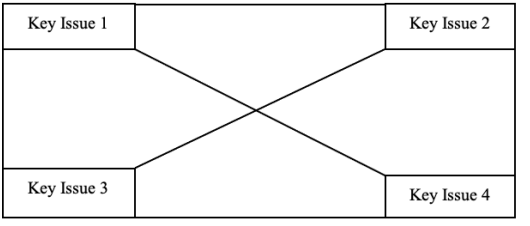

Figure 2. Ideation diagram
Source: developed by authors, 2023.

Implementation Session

In November 2023, a workshop was held with 11 community representatives from Mekarmukti Village, Bekasi, including one village official, four recycling center employees, two homemakers, and four scavengers. The workshop aimed to build on the insights gained during the ideation session and align the vision between the designers and the community. This session focused on refining the issues to identify the most acceptable waste management alternatives. Participants interacted with stimuli, including repurposed waste materials. During the workshop, a consensus was reached on the definition of residual waste, which facilitated a design-focused approach to address it.

Data from the inspiration session were used to guide the selection of residual materials and processing methods that aligned with the community's technical preferences. This activity is proposed as a process model. Following the workshop, material exploration was conducted at the laboratory scale at the ITB campus workshop. The selected residuals were chosen based on their alignment with the types of waste still considered residual by the community and had not been processed at any scale by the community previously.

Equipment and methods were adjusted to fit the community's preferences and capabilities, avoiding lengthy processes and extensive material purification.

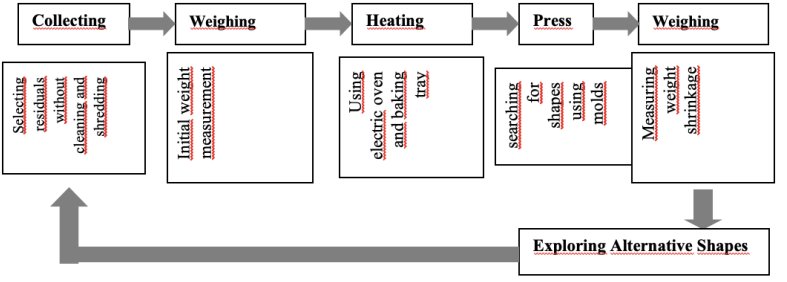

Figure 3. Material exploration flow diagram
Source: developed by authors, 2024.

Village Tanjungbaru, Bekasi, was selected as the site for continuing the participatory design implementation due to the closure of the Recycling Center in Mekarmukti in December 2023, which had originally served as the activity venue. Despite this change, the conceptual and process models developed from the Mekarmukti study can be applied to Tanjungbaru, as the community type and waste generation characteristics are similar. Additionally, the existing relationship between the Mekarmukti Recycling Center managers and the Tanjungbaru Waste Bank managers, both affiliated with PERBANUSA, facilitated the transition to the new site.

RESULT

Identification of Driving Factors

The driving factors were identified based on the factors encountered during data collection, particularly from Mekarmukti, and were subsequently integrated using the diagram shown in Figure 1. Each significant driver was re-evaluated against the internal constraints identified from the data. The results of this analysis are illustrated in Figure 4.

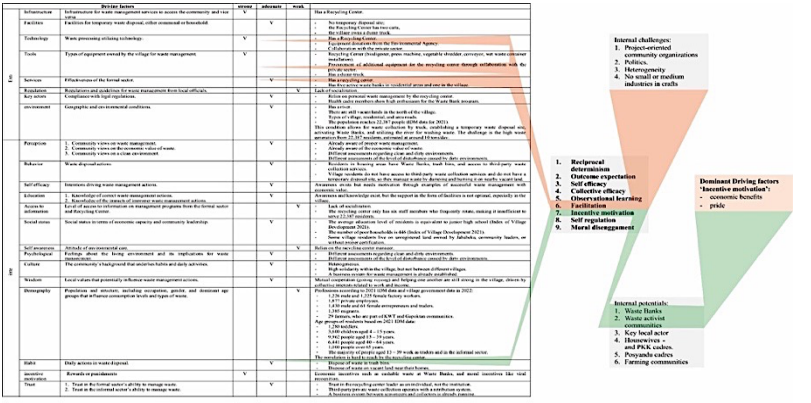

Figure 4. Diagram of dominant driving factors analysis
Source: developed by authors, 2024.

Issue Mapping

Discussions with three experts, including both practitioners and academics, revealed eight key waste management issues based on the data collected in Mekarmukti, Bekasi. These issues, identified through expert analysis, are presented in Figure 5. The mapping results reveal that illegal dumping is linked to community waste disposal practices and insufficient transportation, which hampers the transfer of waste to the Recycling Center. Improper disposal is attributed to difficulties residents face in managing waste, often resulting in burning as an alternative. Waste accumulation arises from inadequate disposal facilities and the inability of scavengers and waste banks to effectively collect residuals.

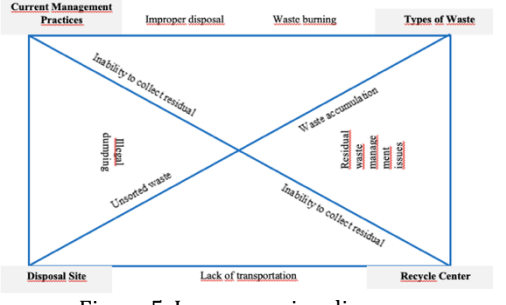

Figure 5. Issue mapping diagram
Source: developed by authors, 2024.

To further explore these issues, a workshop was held on November 18, 2023, at the Mekarmukti Recycling Center, Bekasi, and a discussion with the Tanjungbaru Waste Bank managers took place on May 15, 2024. These sessions aimed to continue problem mapping in collaboration with the community. The findings from these discussions indicate that the community's perception of waste influences the approach to addressing waste issues and solutions. In Mekarmukti, waste is seen primarily as a problem, leading to solutions focused on disposal or converting residuals into money.

Despite the Recycling Center's capacity to address these issues, management problems led to its closure. Conversely, in Tanjungbaru, waste is viewed as a potential resource, prompting solutions aimed at utilizing residuals. Economic drivers are seen as financial gains from the projects, while self-pride factors are perceived as moral benefits. Both types of incentives suggest that projects should be economically valuable and framed as community achievements.

Discussions with the managers of the Mekarmukti Recycling Center and the Tanjungbaru Waste Bank, along with data on the types of waste processed at these facilities, reveal that the community's understanding of residual waste includes any waste that has not yet been monetized. As of this writing, official data on the types and tonnages of residual waste is not available. However, data from waste inflows to the Mekarmukti Recycling Center allows for the categorization of residuals, even though their exact tonnages are not recorded. The residuals can be categorized as follows:

Table 1 –Residual

Plastic Residuals	Non-Plastic Residuals	Organic Residuals
Pigmented PET bottles Plastic bags (*keresek*) Packaging plastics and multilayer plastics Heavily damaged and dirty plastic drink bottles that affect their physical properties Burnt plastic drink bottles Adhesive and oily plastic drink bottles	- Used tires - Electronic waste - Diapers, cigarette butts, sanitary pads	Food scraps

The selected residuals are those that the community has not processed at any scale. Among these types of residual waste, some are present in negligible quantities and their supply cannot be reliably determined, such as heavily damaged, burnt, and oily plastic drink bottles, as well as non-plastic residuals. Pigmented PET bottles can still be monetized, but at a low price. Food scraps are already being converted into animal feed and compost. Therefore, the residuals chosen for further exploration are plastic bags and multilayer packaging plastics.

Figure 6. Workshop in Mekarmukti, November 2023, and discussion in Tanjungbaru, May 2024.
Source: Documented by the Researcher, 2024.

Implementation

The material exploration process is guided by the technical preferences of the community as derived from collected data. A significant challenge during the implementation phase was the closure of the Mekarmukti process were adapted for Tanjungbaru Village, which is in proximity to Mekarmukti and features an active Waste Bank with similar types of residual waste. However, the Waste Bank in Tanjungbaru has limitations, such as a lower investment capacity compared to the Recycling Center. The Tanjungbaru Waste Bank in Bekasi is equipped with a furnace used for destroying residual waste. The heat from this furnace was leveraged to process multilayer plastics and plastic bags, forming the basis for the material exploration session.

The following factors thus constrained the material exploration process:

1. Existing facilities at the Waste Bank/community.
2. There is a need for any additional equipment to be affordable for the community.

3. Minimizing extra activities, such as shredding, sorting, cleaning, or purifying materials, to prevent disruption to daily activities and avoid significant investment.

Laboratory-scale trials utilized an electric oven and a 10-ton hydraulic press. The objective was to process plastic waste without shredding, cleaning, or purifying the materials. The first phase focused on identifying the most effective technique for processing multilayer plastics and plastic bags through heat treatment and pressing, including determining the optimal heating duration and press pressure. Steel molds were used to produce boards with dimensions of 10 cm x 10 cm x 0.7 cm. The molded products were then cut with a saw to test the density and integrity of the processed materials. The ability to cut the material neatly without disintegration suggests potential for alternative treatments and shapes.

Table 2 – Experiment Process and Results for the First Stage

Experiment	Material		Heating		Press	Results	
	Type	Weight (g)	Temperature (°C)	Time (minutes)	Load (tons)	Weight (g)	Shape & Dimensions (mm)
I	Snack packaging and sachets	63	250°	90	1,5	52,5	Box: 8 x 8 x 0,7
II	Snack packaging and sachets	64	250°	40	3	59	Box: 10 x 10 x 0,7
III	Snack packaging and sachets	38,5	250°	60	3	77	Box: 10,3 x 10,3 x 0,7
	Plastic bags (not shredded)	39,5					
IV	Snack packaging, sachets, and plastic bags	100	250°	40	4	78	Box: 10 x 10 x 0,7

The sequence of the experiments is illustrated diagrammatically in Figure 7.

Figure 7. Sequence of material exploration processes for each experiment.
Source: Documented by the Researcher, 2024.

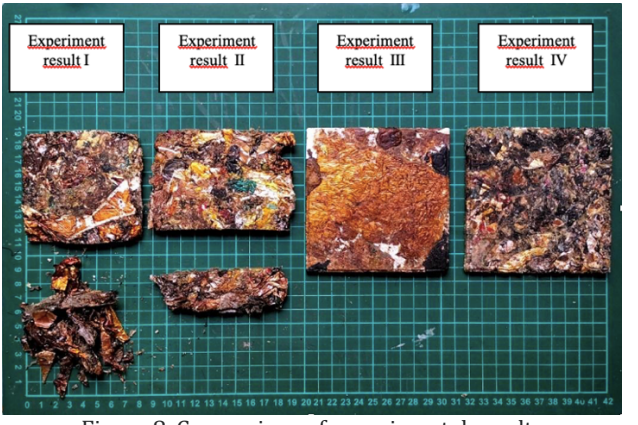

Figure 8. Comparison of experimental results
Source: Documented by the Researcher, 2024.

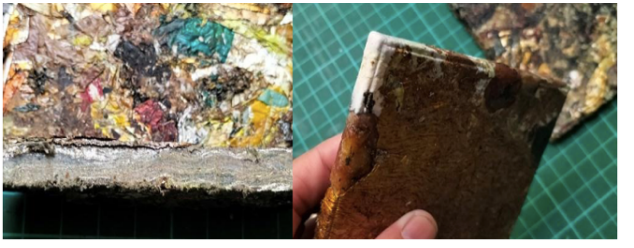

Figure 9. Details of cutting test results and achieved angles
Source: Documented by the Researcher, 2024.

Notes on the results of first stage experiments:

1. Plastic bags can serve as a binding agent, but aluminum foil from multilayer packaging cannot be melted.
2. The weight of materials after heating and pressing shows variable shrinkage. This shrinkage may be due to the waste materials not being cleaned, resulting in residual weight from packaging contents or water. Additionally, some material did not fully transfer into the mold as it adhered to the tray.
3. The best result in terms of material density and shape was achieved in Experiment III, which involved combining multilayer plastic packaging with plastic bags and heating for 60 minutes.

The second stage focused on exploring alternative shapes with curved surfaces, using the process from Experiment III as a model. The mold used was steel, producing a corrugated parquet shape with dimensions of 20 cm x 6.8 cm x 2 cm.

Figure 10. Mold design
Source: Designed and documented by the Researcher 2024.

Figure 11. Results of second-stage experiments with curved surface, including horizontal cuts made with a band saw.
Source: Documented by the Researcher, 2024.

Notes on the results of second stage experiments:
1. The mold results weigh approximately 200 grams.
2. To achieve uniform results, the material to be molded should exceed 200 grams. Excess material can be trimmed using a band saw.
3. The press machine pressure can be increased up to 5 tons.

Figure 12. Surface quality of molded results
Source: Documented by the Researcher, 2024.

Figure 13. Examples of alternative compositions from molded results
Source: Documented by the Researcher, 2024.

As of this writing, design development is ongoing. The composition artwork from the results of the second-stage mold is being proposed. The quality of the surface and structure of the material, which can be cut with a saw, indicates its potential for creating functional products. These design development results will be taken to Desa Tanjungbaru for further production and community collaboration. The design remains under development at the time of writing.

Figure 14. Waste burning furnace at Tanjungbaru used for residual processing
Source: Documented by the Researcher, 2024.

DISCUSSION

Factors Driving Participation in Participatory Design

This study applies Bandura's social cognitive theory to examine the scale of participation and motivation in participatory design. This theory helps explain the dynamics of conflict, participation levels, and engagement within the community. The integration of social cognitive theory into participatory design can be summarized as follows:

1. Observational Learning: Communities can learn from case studies or examples of successful participatory design projects. Small-scale pilot projects that serve as observable models can encourage broader participation across other communities.
2. Self-Efficacy: The belief that individuals and groups can effectively address waste management issues strengthens their confidence to engage in the participatory design process.
3. Reciprocal Interaction: The interaction between behavior, environment, and cognitive processes encourages collaboration among community members, which fosters greater participation.

Operational framework:

1. Identify the dominant factors influencing community participation within participatory design. These factors can be categorized into the core elements of social cognitive theory: personal, environmental, and behavioral factors.
2. Collect data using surveys, interviews, focus group discussions, and field observations.
3. Analyze the data using an integrated framework that aligns these factors with social cognitive theory.

The data indicate that both the Mekarmukti and Tanjungbaru communities are more likely to participate when linked to economic incentives, such as increased income. However, the community also demonstrates pride and a desire to engage when the project highlights their involvement as a significant achievement. Participation in design projects often brings social recognition, which elevates the community's status. Success in these processes enhances self-esteem and confidence, motivating further involvement.

For example, during the Mekarmukti workshop, one participant noted that gaining social media "virality" could motivate greater community engagement. In this context, the Tanjungbaru community had already experienced such exposure, as the local waste bank manager demonstrated strong social media management skills. Therefore, participatory design activities should be structured to promote both community successes and economic benefits. Projects that offer commercial value and can be publicized as community achievements could be effective in fostering sustained participation in participatory design.

Design that Meets the Requirements

The participatory design activities in this research faced several challenges, including limited waste processing facilities, weak investment capacity, and community resistance to significant changes. The design solutions addressed these constraints by maximizing the use of existing community resources, avoiding costly investments or additional space requirements, and minimizing extra tasks such as sorting,

shredding, washing, or purifying materials. This resourceful approach reflects an understanding of local conditions and helps prevent barriers that could arise from the implementation of overly expensive or complex solutions. However, this strategy also presents limitations regarding scalability and long-term sustainability, as the existing equipment may become outdated or insufficient over time. For this reason, progressive yet affordable alternatives should be explored to address future needs.

It is also important that the solution incorporates minimal interventions that can be gradually implemented to enhance the quality of outcomes. While resistance to change is a factor, it should not be addressed merely by avoiding change altogether. There must be space for gradual education and mindset shifts, allowing the community to adopt new approaches without the pressure of immediate transformation. The participatory process in this context focuses not only on utilizing available facilities but also on involving the community in developing new ideas to support future sustainability. Although initial investments may be kept low, long-term planning and capacity building are crucial for sustained success.

From this perspective, participatory design projects, especially in the field of waste management, should be regarded as ongoing initiatives rather than short-term solutions. Designers must remain adaptable, viewing these efforts as long-term engagements that require continuous input and collaboration. Ultimately, the design solutions identified through participatory design seek to strike a balance by addressing the dominant factors that emerge throughout the process. This approach results in a design that is not only contextually appropriate and community-centered but also sustainable and aligned with local needs and capacities (Aulia et al., 2023).

Gaps Faced by Designers in Participatory Design Activities

This section reflects on the challenges encountered during the participatory design process and identifies gaps aligned with the study's objectives. It offers insights for improving

future design activities, particularly within the context of community engagement and participatory methodologies.

1. Fundamental differences in design and design methods.

   A key realization during the research was that design is not merely about producing products or technical solutions but about transforming social situations through human-centered processes. Designers often approach projects with a technical mindset, focusing on tangible outputs. However, participatory design emphasizes social dynamics, collective action, and long-term transformation. This shift requires designers to reassess their role. Are they facilitators of social change or experts controlling technical solutions? The distinction between these roles deeply influences how design is adopted and sustained by the community. A deeper exploration of how designers position themselves in participatory contexts—whether as enablers of change or as authoritative experts—must be pursued to ensure design methods are appropriately aligned with the social context.

2. The role of the community as key stakeholders.

   In participatory design, communities should be recognized as active agents with valuable local knowledge and lived experience, rather than passive recipients of solutions. Designers need to create environments that allow the community to explore, articulate, and test their own ideas. This repositions the designer's role as a catalyst for the creative process rather than its controller. Without a critical understanding of the social and economic hierarchies within the community, so-called "inclusive" participation can unintentionally exclude large segments of the population. Designers must ensure that diverse voices within the community are heard and integrated, especially those traditionally marginalized or excluded.

3. Designer bias and missteps in adopting design thinking.

   Designers may often arrive with preconceived solutions, assuming their proposals are optimal without fully understanding the community's needs, aspirations, and cultural context. This top-down approach overlooks the complexities of local social dynamics. Incorporating a more reflective, sociological lens enables designers to grasp the

intricate relationships, norms, and values that shape a community's acceptance of a solution. Techniques such as "deep empathy" and "rapid ethnography" should be integrated into the design process to better understand community mindsets. This shift from purely structured methods to a more nuanced understanding of the community's lived experience allows for more responsive and contextually appropriate design solutions.

4. Challenges in Increasing Community Motivation.

   Community motivation and participation are often driven by local interests and shaped by complex power relations. Designers must bridge the gap between various stakeholders, fostering trust and a shared sense of ownership over the design process. The social mapping conducted in this study proved useful as an analytical tool but needs to evolve into a collaborative process. By involving the community in "creating" their own social map, the design outcomes are more likely to reflect their actual social realities. This participatory approach not only strengthens community engagement but also empowers individuals to take an active role in shaping solutions that directly impact their lives.

CONCLUSION

A fundamental distinction exists between the conventional understanding of design and the process of designing within participatory frameworks. Participatory design is not merely about creating solutions but about transforming situations through an inclusive approach, acknowledging that systems cannot function effectively without considering the people embedded within them. At its core, participatory design involves stakeholders in co-creating solutions as part of a collaborative problem-solving process. The extent of participation may vary, but the focus remains on aligning the design process with collective community interests.

To maximize its potential, participatory design must be context-specific, directly engaging the community as the primary stakeholder. Designers often enter participatory processes with preconceived notions of what the solution

should be. However, it is the community that will ultimately adopt and live with these solutions. A significant gap arises from this divergence in perspectives—where designers, influenced by their expertise, may offer pre-conceived solutions that do not fully account for the social, cultural, and economic realities of the community. To bridge this gap, designers must develop a more profound understanding of these dynamics, moving beyond traditional design thinking to integrate sociological insights. This sociological approach, which examines the complex interplay of community relationships, values, and power structures, is a skill set that many designers may still lack but must cultivate to be effective in participatory contexts. For participatory design to thrive, designers must engage in comprehensive community mapping to understand the intricate relationships and social forces at play.

Addressing resistance to change requires a gradual, inclusive approach that empowers the community rather than imposing top-down solutions. While practical considerations—such as minimizing additional tasks like waste sorting—may enhance initial acceptance, long-term success hinges on strategies that raise awareness and foster sustainable community empowerment. Thus, it is imperative for designers to develop stronger social skills, facilitation capabilities, and cultural sensitivity to ensure that the design solutions not only gain acceptance but also genuinely reflect the community's long-term needs, values, and local potential. This shift in approach calls for a rethinking of design education, emphasizing the importance of social interaction, collaborative skills, and the ability to build trust through equal dialogue. Ultimately, the goal of participatory design is not only to produce effective solutions but to cultivate a sense of ownership and empowerment within the community, ensuring the sustainability of the outcomes.

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JEPARA WOOD WASTE UTILIZATION AND DEVELOPMENT INTO LIGHTING PRODUCT INSPIRED FROM INDONESIA INGENIOUS VISUAL AND CRAFT

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Abstract

Jepara recognized as the largest wooden furniture industrial city in Indonesia, faces challenges in managing wood waste generated from production. This study aims to develop derivative product designs, specifically lighting designs, that utilize surplus wood waste from production. The design creation methodology involves exploration of visual typology elements derived from Hindu-Buddhist temples, which serve as iconic landmarks of Indonesia, and integrates distinctive carvings characteristic of local craftsmen in Jepara. The result is the creation of lighting products that not only provide illumination but also function as decorative elements that reflect the cultural identity of the region. This research is expected to positively contribute to designers' awareness of the importance of sustainability principles in design, as well as to strengthen the local handicraft industry in Jepara by utilizing wood waste materials.

Key words: Wood-waste, lighting design, ingenious craft

INTRODUCTION

Jepara, a city located in the northern coastal area of Central Java, has historically been a strategic center for trade with India, China, and Arabia, significantly influencing the region's economic, cultural, and religious development. The influence of Hindu-Buddhist culture began to spread across Central Java and Jepara around the 6th century and the art of carving is one of the artistic skills possessed by the local people. The art of carving has been passed down through generations, started originating from the skills of ancestors in Central Java who adorned places

of worship during the Hindu-Buddhist era, as seen in the walls of Borobudur, Prambanan, and other ancient temples. The art of carving and the motif patterns produced by artisans in Jepara have undergone dynamic transformations. (Iswahyudi, 2017)

Presently, the distinctive carvings characteristic of Jepara exhibit intricate motifs and detailed designs, frequently drawing inspiration from local flora, fauna, and folklore. The carving media often used are stone and natural wood, one of the abundant natural materials in Central Java is teak wood. Teak wood has long been utilized by skilled craftsmen for various purposes in the Kalingga, Majapahit, Demak, and Mataram kingdoms since the 7th century. (Purnomo, 2009) The teak wood material also used to utilized as the construction of fishing boats along the coastal areas.

The production and use of teak wood have grown significantly, extending beyond structural needs for traditional houses to include furniture production. During the 19th century, Dutch colonizers targeted teak wood due to its superior quality, meeting the high demand for furniture and timber industries in Europe. As result the local community's wood carving skills were leveraged to produce highly decorative, classic-style chairs with exquisite craftsmanship.The aesthetic expression of Jepara carving art has evolved to meet evolving consumer demands, incorporating European-style furniture. (Muhajirin, 2019)

The craftmens of Jepara are renowned for their ability to create three-dimensional carvings with realistic depth and texture, frequently applied to wall decorations, and traditional carved doors known as 'gebyok'. The majority of wood carving technology in Jepara is still conventional and manual, resulting in slow production and product quality for the export market. (Marizar, 2020) This condition has also diminished the interest of younger generations in continuing the tradition, raising concerns about the regeneration of wood carving art among them.

On the other hand, the need for wood raw materials in furniture production continues to increase, accompanied by an increase in the amount of unused wood waste and of course it will be a new problem that needs to be solved. In order to be

managed wisely, environmental ethics and environmental legal awareness are needed so that this waste can be managed effectively. (Setiawan, 2023)

Over the past ten years, the furniture industry has needed around 3 to 3.8 million cubic meters of wood per year, with an estimated 10-20% of which is waste. This waste includes wood chips and sawdust, which are often unused for reasons of efficiency. Upon closer examination, this waste presents a significant potential opportunity for creating derivative products that support sustainable principles for the furniture industry, especially as the supply of solid wood continues to diminish.

The principles of sustainable design aim to minimize negative environmental impacts and reduce the use of non-renewable resources by lowering pollution, waste, energy consumption, and reliance on scarce materials. (Bhamra, 2007) Additionally, these principles promote a harmonious interaction between people and the natural environment. (Shouha, 2007) This study seeks to explore the potential of utilizing wood waste to create functional and decorative products by optimizing the use of small and medium-sized wood pieces.

It also examines the visual characteristics of cultural heritage, as reflected in artifacts like temples and historical buildings, which possess lasting aesthetic and cultural value. The integration of visual characteristics from Indonesia's cultural heritage, particularly the architecture and graphic arts found in ancient buildings and temples, aims to enrich design inventories while raising awareness of the importance of design exploration rooted in the past as an expression of cultural identity. By combining sustainable design principles with local wisdom, this approach offers creative inspiration to tackle environmental challenges within Jepara's furniture industry.

METHODS

This study employs a qualitative design exploration methodology, divided into several phases:

1. Data Collection and Analysis of Wood Waste Materials and

Visual Elements. The first phase involves analyzing the types of wood waste from furniture production in Jepara. The collected waste includes leftover wood pieces, corroded wood, and unused wood from the carving process. The waste materials are then categorized based on their size, texture, and potential use in the design process. Additionally, an analysis of visual elements from prehistoric temple buildings was conducted. Some temples located in Jepara have not been fully restored, making it difficult to define their visual elements. Therefore, Borobudur and Prambanan temples in Central Java, with their fully restored visual compositions, were used as reference objects. The design elements collected include lines, planes, volumes, form compositions, joinery systems, and key visual details of these heritage buildings.

2. Design Exploration
   The next phase involves design exploration by integrating visual elements from Hindu-Buddhist temple architecture as the primary form concept. The design exploration includes analyzing the visual elements of temple forms and structural patterns and translating them into product design concepts. The selection and adjustment of wood waste materials are carried out to match the design of the lighting products being developed. Additionally, traditional carving techniques of Jepara craftsmen are integrated into the designs to enhance the cultural authenticity of the products.

3. Design Simulation
   This phase involves the application and simulation of the products in a spatial context. Considerations include form principles, dimensional proportions, and the quality of lighting effects produced. Technical tests and observer feedback are gathered to evaluate the design, and based on these tests, further improvements are made to refine the design

4. Prototype Development

Based on the design exploration, several pendant lamp prototypes were developed using the collected wood waste. These prototypes are evaluated based on aesthetic and functional quality, with a focus on ensuring that the final products are visually appealing, structurally sound, and environmentally sustainable. The prototypes are produced to test the final outcomes of the designs.

RESULT

This study analyzes wood waste materials produced by the furniture industry in Jepara, alongside an examination of visual elements derived from ancient cultural artifacts in Jepara and the surrounding areas of Central Java.

The Wood Waste and Visual Elements

Regarding the wood waste materials, several types of waste generated by the industry in Jepara were identified. It is estimated that 10-20% of the wood used in each furniture or wood-based product production results in waste that can be repurposed. The types of industrial wood waste include wood offcuts, sawdust, and decomposed wood pieces, commonly referred to as corroded wood. The following images and tables provide a detailed breakdown of these waste types.

Figure 1. Industrial Waste: Offcuts, Sawdust, and Corroded Wood.
Source: Authors Data.

Table 1 – The Waste Study of Wooden Industry

Type of Waste			Description
Wood Waste	**Dimensions**	**Persentage**	
Off-cuts	Wood offcuts of various sizes	10-15%	These are wood pieces left unused during the cutting process. Sizes vary from small to medium, depending on the type of furniture being produced.
Sawdust	Fine wood particles (sawdust)	5-10%	Produced during the cutting, sawing, and sanding processes. Sawdust is typically generated in large quantities and is often repurposed as biomass fuel or for by-products like particle boards.
Branch and Log Pieces	Small branches or logs with irregular dimensions	8-12%	Unused parts of wood after the selection of primary materials, usually shaped as logs or branches that are too small to be used in large furniture production.
Wood Chips/Splinters	Irregular wood fragments or chips	3-5%	Splinters and chips produced during furniture manufacturing, such as precision cutting, often irregular in shape or too small to be used in main products.
Large Offcuts (Waste Slabs)	Large unused wood pieces	5-7%	Large pieces produced from the initial wood cutting stages that do not meet desired sizes or shapes. These are often in the form of slabs or blocks.
Unusable Wood	Damaged, broken, or cracked wood	2-4%	Wood that is unusable due to natural defects or because it became cracked or damaged during the production process. It is usually separated from the selected raw materials for high-quality products.
Corroded Wood	Unprocessed leftover wood that has been discarded and left to naturally decay	Not yet identified	Wood that is left unused and has undergone corrosion due to natural weathering and erosion, leaving behind parts of the wood structure that remain hard.

Based on literature studies on local culture, it was found that temple buildings are significant artifacts representing the rich artistic heritage of the socio-culture and religion of Javanese people. (Perdana,2022) The craftsmanship of wood carving is reflected in the grandeur of the temple structures and the

beauty of the carvings that adorn the temples, which served as places of worship for Hindu-Buddhist communities, particularly in the Jepara and Central Java regions. These carvings showcase the high level of artistic skill and symbolism possessed by the people of that era, making temples symbols of cultural and spiritual heritage.

Table 2 – Visual Study of Cultural Artifacts

Cultural Artifact				Visual Elements
Borobudur Temple	Magelang, Central Java	8th Century CE (760-830 CE)	Buddhist	• Square, rectangular, and circular base • Radial symmetry • Tiered and expanding • Parallel line elements • Carvings of gods, humans, flora, fauna, and mythology
Mendut Temple	Magelang, Central Java	9th Century CE (824 CE)	Buddhist	• Square base • Symmetrical • Tiered and towering • Parallel line elements • Carvings of gods, humans, flora, and fauna
Pawon Temple	Magelang, Central Java	9th Century CE	Buddhist	• Square, rectangular, and circular base • Radial symmetry • Tiered and towering • Parallel line elements • Carvings of gods, humans, flora, fauna, and mythology
Prambanan Temple	Sleman, Central Java	9th Century CE (850 CE)	Hindu	• Square base • Tiered and towering • Parallel line elements • Carvings of gods, humans, flora, fauna, and mythology
Angin Temple	Jepara, Central Java	9th-10th Century CE	Unidentified	• Square base • Tiered and towering • Unidentified carvings
Bubrah Temple	Jepara, Central Java	9th-10th Century CE	Unidentified	• Tiered • Towering • Unidentified carvings

Aso Temple	Jepara, Central Java	9th-10th Century CE	Unidentified	•	Flat base • Unidentified carvings
Bentar Temple / Gapura / Gerbang Terbelah	Jepara and Central Java Region	Unidentified	Unidentified	•	Rectangular base • Symmetrical • Balanced • Tiered and towering • No carvings

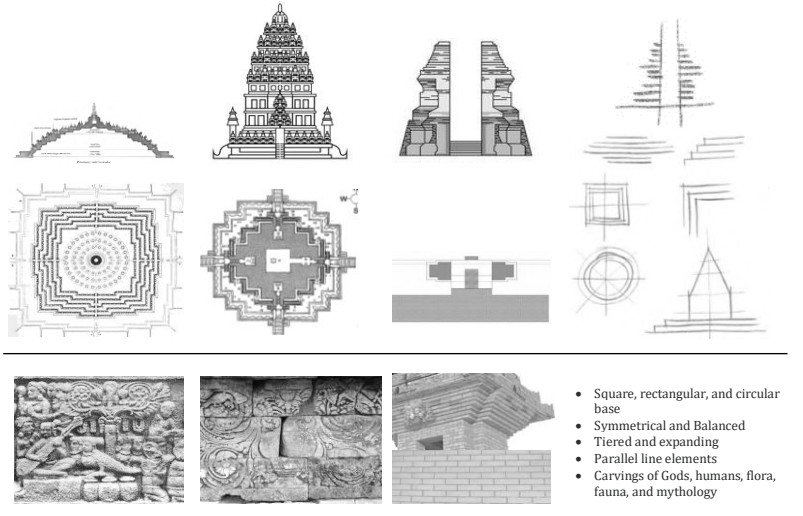

Figure 2. Typology of Temple and Visual Element Forms
Source: Internet Access, 2024.

From the visual study of ancient temple building artifacts, several notable visual characteristics were identified. These include foundational shapes such as squares or circles with radial symmetry, tiered structures, forms that either expand outward or tower upward, and parallel line elements (Table 2). Additionally, organic carving elements are often present. These visual elements will serve as key assets in the development of lighting products using previously mapped industrial wood waste materials. Subsequent design explorations will be based on the unique characteristics of each finding.

Design Concept and Exploration

The utilization of wood waste to create new products is centered on principles of sustainability. The integration of artisans' carving skills and the wealth of visual elements derived from historical architecture adds significant value in enriching the design exploration. These concept showcase visual elements inspired by Hindu-Buddhist temples as historical artefatc, combined with the traditional craftsmanship skills of Jepara artisans. The whole concept are illustrated in the diagram below.

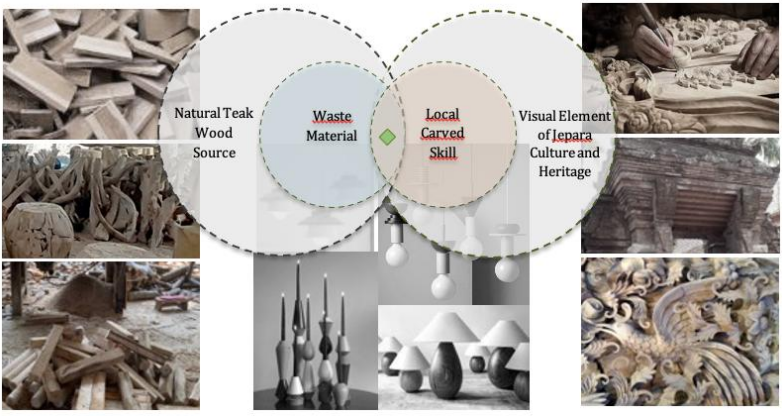

Figure 3. Concept of Developing Wood Waste Design into New Products
Source: Authors Data.

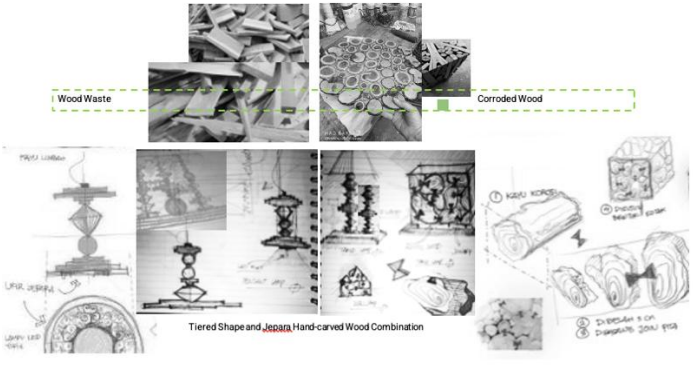

Figure 4. Exploration of Wood Waste Design into Lighting Products
Source: Authors Data.

The Designs

The results of this study demonstrate the successful creation of lamps utilizing wood waste materials while integrating Indonesia's cultural heritage into their designs. The exploration revealed four design types that utilize materials such as wood off-cuts, branch/trunk segments, and corroded wood. The wood waste materials in the form of sawdust and smaller wood pieces were not further explored, as their processing requires a different method, specifically pressing to create boards from the wood particles. By selecting the appropriate types of wood waste and combining them with various visual elements and techniques, four chosen designs were developed, which will be detailed in the following table:

Table 3 – Design Exploration Result

Design	Waste Types	Visual Element	Tecnical	Function
Design 1	Wood Off-cuts	Temple Visual Outline: • Square base • Tiered • Parallel lines • Rising upward	Joinery System: Compact Slip; interlocking Finishing Material: Natural	Pendant Lamp Dimensions: 25x25x15
Design 2	Wood Off-cuts Wood Chips/Splinters Branch Cuts	Temple Visual Element: • Square base, rectangular • Tiered • Parallel lines • Rising upward • Jepara carved with flora	Stacking Installation Technique	Pendant Lamp Dimensions: 32x32x17
Design 3	Wood Off-cuts Wood Chips/Splinters Branch Cuts	Visual Elemen Candi: • Temple Visual Element: • Circular base, Raounded • Tiered • Parallel lines • Rising upward • Jepara carved with flora	Stacking Installation Technique	Pendant Lamp Dimensions: 22x22x17
Design 4	Wood Off-cuts Wood Chips/Splinters Branch Cuts	Visual Element: - • Square base, rectangular • Tiered • Abstract and organic elements	Joinery System: Dove-tail to expose desired detail	Table Lamp Dimensions: 35x35x40

Design 1	Design 2	Design 3	Design 4

Four designs with distinct characteristics were selected. Design 1 prioritizes the visual outline of the temple structure, while Designs 2 and 3 emphasize the tiered and upward-reaching forms, incorporating repetitions of parallel lines, along with radial and circular elements. The arrangements in Designs 2 and 3 lend a slightly contemporary visual style suitable for casual spaces. To enhance aesthetic value, characteristic Jepara carvings, specifically floral motifs, were also applied. The final design explores corroded wood waste, transformed into a table lamp to highlight the unique character and texture of the material.

Additionally, dovetail joinery was incorporated to strengthen the structure. The selected designs will proceed to the production of working drawings, which serve as a guide in the prototyping process. These working drawings are meticulously crafted to include the dimensions and shape details of each product element, as well as the technical information necessary for assembly. By incorporating clear specifications, the working drawings not only ensure that all design aspects are accurately implemented but also facilitate collaboration among the various parties involved in the production process.

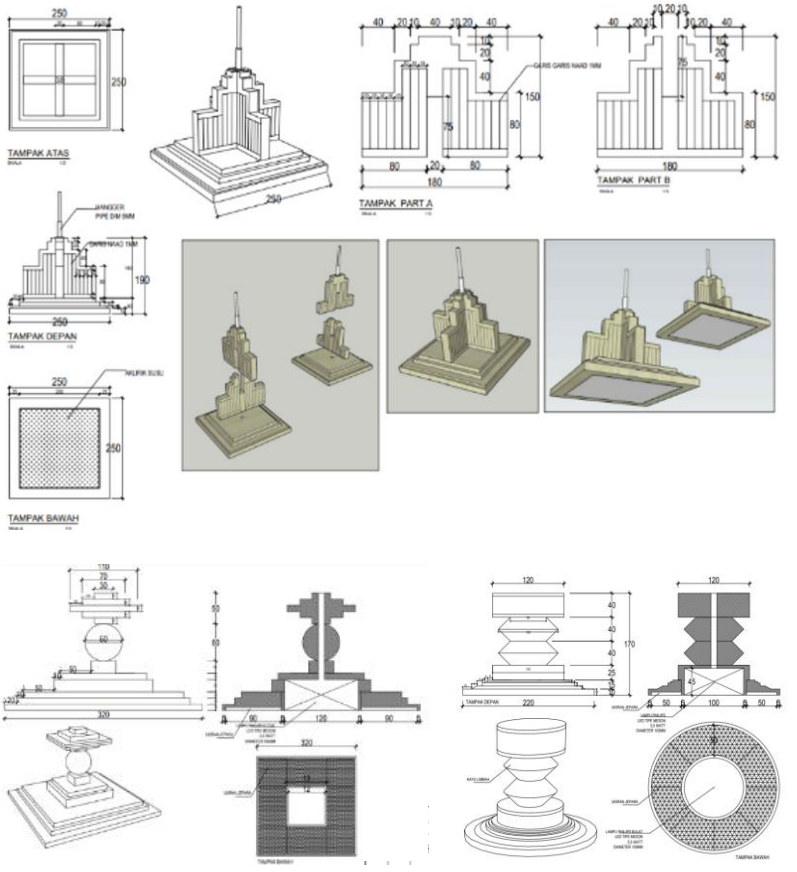

Figure 5. Working Drawing: Design 1, 2, and 3
Source: Authors Data.

Design Simulation

The lamp design simulation was conducted to evaluate the product's compatibility with interior environments, using the 3D digital model of traditional Joglo building as the primary reference. The simulation results indicate that the developed lamp design aligns well with the characteristics of Joglo interiors, where wooden elements and traditional carvings serve as the main focal points. Additionally, the application of this lamp design is deemed suitable for other interior concepts,

such as classic, eclectic and contemporare styles for public or private space.

Figure 6. Carving Process for Lamp Fixture Designs 2 and 3
Source: Authors Data.

Prototype Making

In the prototyping process, the technical aspect of selecting materials from wood waste is a crucial consideration. Choosing suitable wood waste for specific design types is essential. Therefore, sorting the wood waste must be carried out before entering the production stage. This ensures that only appropriate and high-quality materials are utilized, leading to an optimal final product. Additionally, several tools such as planners, lathes, cutting machines, as well as chisels, hammers, and sandpaper are needed to support the production process.

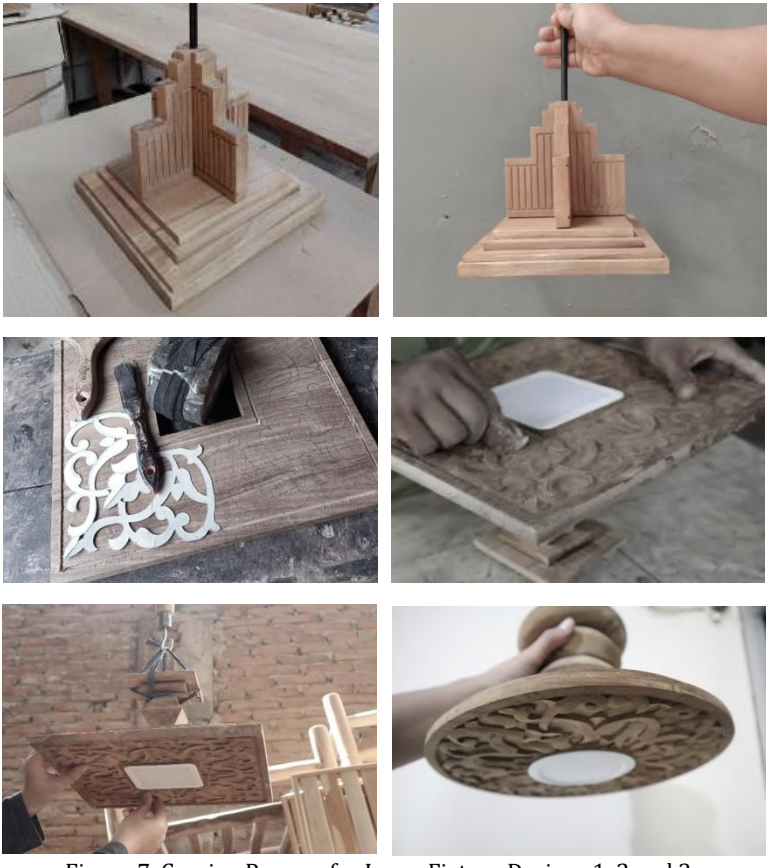

Figure 7. Carving Process for Lamp Fixture Designs 1, 2 and 3
Source: Authors Data.

In the prototype production process, local carvers are relied upon. These artisans are residents of Jepara who possess skills in teak wood carving and are accustomed to creating intricate carvings for chairs and “gebyok” panels, which are one of the hallmark products of Jepara's carving artistry. The work is carried out manually, emphasizing the carvers' craftsmanship and skill in the carving process.

The lamp designs developed in this study are inspired by Indonesia’s indigenous visual and craft heritage, particularly the visual elements found in Jepara’s artifacts and Javanese culture.

owever, critical aspects such as production costs, marketing strategies, and other logistical considerations have yet to be thoroughly investigated. Further research is essential to establish an effective and efficient production system, particularly for large-scale industrial manufacturing. This would also necessitate addressing human resource management and potentially incorporating advanced technologies. Ultimately, the lamp designs will be tested and refined to align with the intended ambiance, particularly for interior designs in classical, traditional, or eclectic styles.

CONCLUSION

This research demonstrates the potential of utilizing wood waste from the industry in the development of lighting products. Several types of wood waste were identified, including off-cuts, sawdust, and corroded wood. Off-cuts and corroded wood are further developed in this paper, while sawdust requires special treatment before processing, specifically by undergoing a compression process to create panel boards. Through analysis based on cultural artifacts such as ancient temples and other crafts, the visual elements including lines, planes, and forms were identified as the ingenious visual and utilized as design components, resulting in innovative outputs that reflect the distinctive visual heritage of Indonesia.

The lamp designs produced in this study serve as examples of sustainable design that not only address environmental issues but also promote local craftsmanship and the unique carving identity of Jepara. By enhancing awareness of sustainability principles in design, this research contributes to broader discussions regarding the role of designers in exploring visual elements and design from a cultural perspective, as well as creative collaboration with local industries to confront global challenges.

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BAMBOO COILING JEWELLERY: NATURE'S ELEGANCE IN DESIGN

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Abstract

Bamboo is one of the abundant natural resources in Indonesia, so bamboo handicraft products can be easily found there. The most widely used technique is the plaiting technique. Many woven bamboo crafts use coiling as a framework for woven products. Although it is often juxtaposed with the popular plaiting technique, the coiling technique is less glamorous and has yet to be developed in Indonesia. This is because coiling has a basic circular shape and is difficult to make in small diameters, ultimately becoming an obstacle to product development using the coiling technique. Bamboo processing also adds to the challenges for craftsmen as bamboo is susceptible to mold and bamboo-destroying organisms. The sustainable market and fashion and jewelry products are popular today, especially among Gen Z. Gen Z, is the key target market for jewelry styling in this design. Gen Z preferences, mainly explored through CJM and questionnaires, will be the main consideration in the design process. Meanwhile, bamboo processing will be explored through field studies of related products and techniques and various experiments needed, such as bamboo type, preservation, coiling form, joining, and coiling finishing. These methods are used to support the design process of bamboo coiling jewelry that suits the preferences of Gen Z.

Key words: Bamboo, Coiling, Jewelry

INTRODUCTION

Coiling is a technique of rolling or winding thin bamboo sheets (bamboo strips) with attention to angles and curves. (Nurfauziah et al., 2023) Coiling is widely developed in Vietnam

and has been applied for centuries. (Nurfauziah et al., 2023; Rahmadani & Hakim, 2019) In Indonesia, the coiling technique is still less popular than the plaiting technique due to the limited number of craftsmen, caused by a lack of knowledge and socialisation of the technique. In fact, coiling is a derivative of the plaiting technique and has been used in the manufacture of several woven products such as tampah, steamer, and basket.

The lack of popularity of coiling products in Indonesia hinders the development of product variations. SMEs' creativity is hampered by the notion that product innovation requires a lot of experimentation with new tools and skills, which increases production costs and uncertainty of results. (Waskito, 2014) In the field, coiling products are still handmade by artisans under SMEs. Coiling products that are widely developed in Indonesia are home decor and furniture, with limited variations. A similar situation exists in the fashion industry, especially in jewellery making, where bamboo coiling techniques are rarely used. However, Indonesian brands Ouboo and Pablo Luna have successfully created jewellery using the bamboo coiling technique.

Coiling products are mostly made manually with tools and materials that are common in Indonesia. Skilled Indonesian artisans should be able to easily apply it, but this is not the case. This is unfortunate because through SMEs and MSMEs, many jobs can be created. According to the Ministry of Cooperatives and SMEs, MSMEs in the field of fashion contributed 18.15% and crafts 15.70% of 7.38% of the total national economy with a total GDP of around Rp. 852.24 trillion. (Asmoro & Meirinaldi, 2021)

Figure 1. Fashion and Jewellery Product Consumers by Age
Source: blog.gwi.com / What to know about targeting fashion and jewelry Buyers/Trifonova 2021

Based on the data, it is known that Generation Z, born between 1995 and 2012 with a current age ranging from 12 to 27 years

old, dominates the fashion and jewellery market. This is because Generation Z tends to see fashion as a means to express their identity, lifestyle and self-expression.

Figure 2. Characteristics of Gen Z Consumerism
Source: www.euromonitor.com / Unlocking the Gen Z Code to Revolutionise Jewellery Sales /Linares 2024

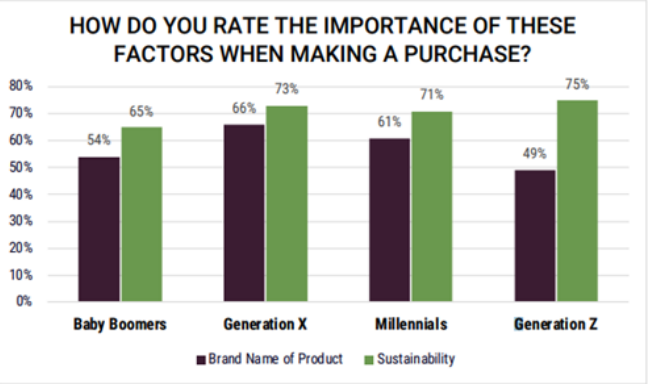


Figure 3. Product Purchase Motivation of Each Generation
Source: www.weforum.org / Gen Z cares about sustainability more than anyone else – and is starting to make others feel the same way/Wood 2022

According to Euromonitoring International, 20% of Generation Z choose fashion products and accessories based on current trends to explore and express their style. This leads them to shop for fashion products at least three times a year. Gen Z also tends to use social media actively, reaching 60%

higher than the global average. The impact is seen in their fashion purchasing habits, where many choose to shop through e-commerce platforms. In addition, the 2023 survey results show that 55% of Gen Z is concerned about climate change. (Linares, 2024) This makes Generation Z more mindful of the environmental impact of their consumption activities and tend to favour products that are environmentally friendly and socially responsible. (Hidayati, 2023)

Bamboo material is highly supportive as a sustainable product due to its abundant potential in Indonesia reaching 10.4 million tonnes, with rapid growth within 3-5 years. (Rizqi et al., 2023) In addition, bamboo has positive environmental impacts, such as 30% greater oxygen production than timber forests, watershed enhancement, erosion prevention, restoration of degraded soils, and neutralise toxins from contaminated soil. (Artiningsih, 2012) Seeing the many opportunities of bamboo coiling jewellery development and Generation Z's great interest in eco-friendly products, the topic of bamboo coiling jewellery for Generation Z was chosen with a focus on sustainable, natural, and exclusive concepts. '

The sustainable concept is adapted to create products that are environmentally friendly. The natural concept is applied by adopting the shape of Indonesian endemic flowers. The natural concept is applied to support the sustainable concept by using natural materials and the concept of the shape of Indonesian endemic flowers, as a form of jewellery. In addition, in this design, the exclusive concept is raised to match the preferences of buyers (Gen Z), with options for customisation and personalisation of products according to their preferences.

Problem statement

1. The limitation of thinking that coiling can only be circular and cannot be small.
2. Market opportunities for sustainable and fashion products in Gen Z, which is Indonesia's largest population to day.
3. The abundant potential of bamboo and the potential of wicker craftsmen in producing bamboo coiling products in Indonesia.

4. The low selling value of bamboo in Indonesia has the potential to be used as raw material to increase its selling value.

Jewellery is an object used to beautify oneself and support one's appearance. (Hendranto, 2019) Bamboo is a plant that has high strength and elasticity that allows it to be processed into various shapes while remaining sturdy. (Mutiara et al., 2021) Coiling itself is a technique of winding thin bamboo sheets (bamboo slices) repeatedly by paying attention to the large angle in the curve of the shape you want to make. The smaller the angle the more difficult the coiling is. (Nurfauziah et al., 2023)

Field studies were also conducted to expand the range of information that could be obtained. The field study was conducted at Bamboo Tutul (Magelang, Central Java) to explore information related to bamboo coiling with the conclusion of the discussion with the owner of Bamboo Tutul, Mr Yudi that coiling can illustrate the characteristics, skills, accuracy, neatness and ability of the maker. Robustness, appearance and function determine the success of bamboo coiling products. Re-application of finishing should also be done regularly to prevent bamboo coiling from mould and damage.

The second field study was conducted at Joglo Ayu Tenan (Sleman, DI Yogyakarta) to gather information related to bamboo jewellery with the conclusion of the discussion with the owner of Joglo Ayu Tenan, Ibu Yayuk, that the combination of uncured bamboo with metal will oxidise the metal. Another obstacle is related to precision, where it is difficult to make handicraft products using natural materials for mass production. But that's where the value of uniqueness and exclusivity of the product can be raised.

Based on field studies, it is evident that bamboo is highly susceptible to damage without proper processing. The high moisture content and starch content of bamboo can reduce its durability. This can be overcome by preservation. Preservation can be done non-chemically by soaking the bamboo in water or mud for a duration of 1-24 weeks or fumigating the wet bamboo for 15-20 minutes. (Laarasati & Tristiyono, 2019; Tumonglo et

al., 2020) While chemical preservation can be done by boiling the bamboo using salt water for 15 minutes or soaking the bamboo in petrol, baron, zinx chloride, sodium penda chloror phenate, copper chrome acenic, copper chromium baron or karosete with a certain composition. (Laarasati & Tristiyono, 2019) In addition to preservation, as Mr Yudi said in the Bamboo Tutul field study, regular finishing can protect bamboo coiling from damage. Bamboo finishing can be done by applying wood stain, tung oil, bees wax, and waterbased lacquer. (Laarasati & Tristiyono, 2019)

Gen Z is the generation born between 1995-2010. They grew up with technology, making them highly skilled in using technology and always expecting technological innovations. (Rachmawati, 2019) Interestingly, Gen Z has the best environmental awareness of any generation. (Wood, 2022)

METHODS

1. Literature Study

   Literature study is the process of collecting, reviewing, and analysing various sources such as books, journals, and articles related to the research topic. This method aims to understand current issues in depth (Amin Lasaiba, 2022). This literature study includes journals, articles, reports, and trusted websites published in the last 5 years. Materials collected include Gen Z characteristics, bamboo jewellery, bamboo processing and dyeing techniques, and current design trends.

2. Document Study

   Document study is a technique of collecting data from various written documents, images, or other works, which are then analysed to obtain systematic study results. In this research, document studies use images, photos, and videos from various sources such as Youtube, Google Lens, and Pinterest to support the course of research and data visualisation.

3. Questionnaire

   A questionnaire is a form filled out by respondents to collect data, in this research it is used to find out the preferences of gen Z towards bamboo jewellery with the

coiling technique. The questionnaire used Google Forms for efficiency and was distributed online via Whatsapp and Instagram.

4. Expert Interview

   Expert interviews are conducted with experts in related fields to gain knowledge and input related to product development. In this research, interviews will be conducted with natural material jewellery experts and bamboo coiling experts.

5. Customer Journey Mapping

   Customer Journey Mapping (CJM) helps designers understand the user experience from the stage of knowing to using the product, as well as identifying pain points and gain points to prevent problems that may arise in the design product.

6. Experimentation/Exploration

   Experimentation is a method to find out the impact of a treatment that is deliberately carried out. In this research, experimentation is used to deeply understand the characteristics of bamboo to determine the optimal processing method.

SUBTITLE

1. Questionnaire

   The survey was conducted on 52 female Gen Z respondents with an age range of 19 to 29 years. The survey results showed preferences on jewellery design, material and budget. The majority of respondents chose to wear jewellery for special occasions with less than 6 hours of wear per piece. Bamboo was preferred as the main material with a tendency towards natural colours and silver-coloured metal as the supporting material. The majority of respondents were also willing to use bamboo jewellery, but preferred trinkets with small dimensions. Thus, the jewellery design will feature organic shapes with a casual and elegant theme. In addition, the jewellery will be sold in the price range of IDR 100,000 to IDR 500,000.

2. Mood Board

   Moodboards are used to provide a visualisation of the

concept with related images such as materials, atmosphere, target user outfit, and more. It helps designers maintain a well-defined theme. The moodboard includes photos that reflect Gen Z's daily life and preferences, and includes the main keywords, colour palette, and materials and shapes that will be used in the jewellery design. This research will create jewellery with Indonesian endemic flower designs, incorporating elements such as daily activities, routines, likes, outfits, places, and things related to Gen Z listed in the moodboard.

Figure 4. Mood Board
Source: Processed by the author from various sources.

Figure 5. Image Board
Source: Processed by the author from various sources.

3. Image Board

The image board contains images of jewellery in terms of shape, mechanism, concept, material and manufacturing

techniques for the development of bamboo coiling jewellery products. The jewellery design will take on floral shapes with the concept of interchangeability, as Gen Z likes personalised customised products. A joining system will be used to connect each piece of jewellery. The jewellery to be made is bamboo coiling jewellery that applies asymmetrical concept, especially for earring jewellery.

4. Explorations

Aims to explore different types of bamboo by observing their characteristics. The thickness of the bamboo slats used for bamboo coiling is less than 1 mm. The following is the process of making coiling for the exploration of bamboo species.

Table 1 - Stages of Making Bamboo Coiling

1. Shaving Bamboo	2. Splicing Bamboo	3. Levelling the Joint
		
Cutting the divider between the bamboo segments to facilitate the bamboo shaving process.	The bamboo slats are joined using G-glue for length.	The joint parts are sanded to make the coiling look neat.

4. Coiling the Bamboo	5. End the Coiling	6. Applying Wood Glue
		
Bamboo is rolled using a coiling tool to the desired size.	The ends of the bamboo slats are glued with G glue so that the coiling results do not decompose again	Bamboo coiling is treated with wood glue on the top and bottom so that the structure is sturdy and the shape is fixed.

7. Drying the Coiling	8. Caulking	9. Drying the Coiling
		
Coiling is dried in the sun so that the glue dries completely.	Seal the coiling cavities using a mixture of wood glue and bamboo sawdust.	Coiling is dried in the sun so that the putty dries completely.

10. Sanding the Coiling	11. Finishing
	
Sanding is done to flatten the surface of the coiling so that the bamboo fibres can be seen.	Finishing is done to give the coiling a protective layer and an attractive appearance.

From this process, the following are the results of the observation of the exploration of bamboo species:

1. Type of Bamboo

   The bamboo species explored were selected based on their availability in e-commerce and the area around the design, namely the ITS area to ensure availability during the research. Each bamboo has a different character. Of the eight bamboo types, black bamboo is the easiest to coil due to its elastic and unbreakable fibres, as opposed to ater bamboo whose fibres are easily dispersed making it quite difficult to coil. As for colour, ori bamboo and black bamboo have the most suitable colours to be applied to jewellery as ori bamboo has the brightest colour and black bamboo has a distinctive colour. Since appearance is an important point of jewellery, ori bamboo was chosen to be used in this design.

Table 2 - Coiling Various Types of Bamboo

Bambusa blumeana	*Bambusa vulgaris*	*Gigantochloa apus*	*Gigantochloa pseudoarundinacea*
			
Gigantochloa atter	*Dendrocalamus asper*	*Schizostachyum brachycladum*	*Gigantochloa atroviolacea*
			

2. Coiling Forms

   The basic shape of coiling is a circle, but because in this design coiling will be implemented on jewellery with the inspiration of endemic flower shapes, an exploration of the shape of coiling was conducted. The exploration of shapes uses the basic forms of the quilling paper technique, which is similar to coiling, except that the material uses paper. Exploration of the basic shapes of the quilling technique was successfully carried out using relatively thin strips of bamboo. In this exploration, the shapes chosen were closed shapes rather than patterned ones so that the coiling does not have many voids that complicate product maintenance.

Figure 6 Exploration of Coiling Shapes
Source: Author's processing.

In this exploration, it was also found that it is possible to achieve small coiling sizes by considering the thickness of the bamboo strips. The thinner the bamboo strips, the smaller the inner diameter that can be achieved, the smaller the coiling size can be made.

3. Joining System between Bamboo

   Joining between bamboos is done to find the best connection between bamboos to apply to the coiling, joining between bamboos is necessary because one bamboo segment is sometimes insufficient to make one coiling. A parallel joint does not interfere with the shape of the coiling, but in appearance the connection between bamboos is very visible, characterised by a small ronga at each part of the joint. The overlapping joint is the easiest type of joining to do, but the overlapping part of the joint is very visible in appearance,

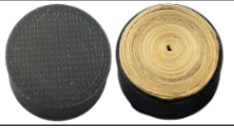
which ultimately affects the shape of the coiling. Of the three types of joins explored, the scarf join is the most time-consuming due to the longer process involved, but is the best join in terms of structure and resulting appearance as it does not interfere with the appearance of the bamboo fibres and the shape of the coiling so this is the join used in the coiling.

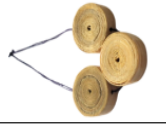
Table 3 - Exploration of Joining between Bamboo Strands

Paralel	Overlap	Scarf
		

4. Joining System between Materials
   Exploration of joining between materials was carried out using 3D printed models. Of the six types of joins, all joins can be implemented in coiling. Each joining has its own intended use. However, the most potential to be applied in this design is the beading and list joining because the coiling can be clearly exposed without the joining being disturbed. In addition, in terms of maintenance, it will also be easier because the bamboo is exposed.

Table 4 - Exploration of Joining between Materials

Frame	Stab	Clasp
		

List	Crown	Bead
		

5. Finishing

   Finishing exploration was conducted to find the most suitable type of finishing to be applied to bamboo coiling jewellery. The finishing results are divided into two, namely glossy and matte finishes. Glossy finishing can be achieved by using nail polish, varnish and spray paint. While doff finishing can be achieved using linseed oil and beeswax. Glossy finishing adds to the lustre of the bamboo. Texturally, the use of linseed oil is most effective in maintaining the natural texture of the bamboo even after finishing. In terms of safety (water resistance) all types of finishing except linseed are able to protect the bamboo by forming a finishing layer that covers all the pores of the bamboo. However, since the concept of this design is natural, linseed oil was chosen as the finish because it is still able to showcase the natural texture of the bamboo and this type of finish is also made from seed oil so it is chemical free and safe for the skin.

Table 5 - Finishing Exploration

Nail Polish	Varnish	Spray Paint
		

Linseed Oil	Beeswax
	

RESULT

The realisation of ideas begins with the visualisation of ideas into ideation sketches. The initial ideation sketches were done to search for the broadest form possible. From the 30 ideation sketches made, 3 ideations were selected which were then developed into 15 ideations and then the following top 3

ideations were selected to be realised into the final product. Furthermore, a 3D model was made as an operational and size simulation to minimise product failure.

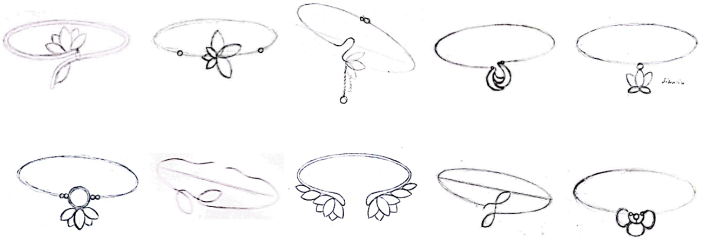


Figure 7 Ideation Sketch
Source: Author's processing

Figure 8 3D Modelling Design
Source: Author's processing

After the 3D model is deemed to be in accordance with the target size and assembly system is deemed successful, then proceed to the process of making a model study using the original material according to the size and shape of the 3D that has been made. This is done to find out the characteristics of the material in the field, whether the design can actually be realised with the specified material or not. If this initial prototype is successful and there are no problems in the manufacturing process or built quality, then the final prototype can be made.

Figure 9 Low Fidelity Prototype
Source: Author's processing.

The final prototype was made with an interchangeable pin system to support Gen Z's preference for customised and personalised products. Thus, by using magnetic pins in the form of endemic flower shapes, users are expected to be more able to express and create through the bamboo coiling jewellery. Endemic flowers were chosen as the inspiration for the shape of the magnetic pins with the hope that the jewellery can also serve as a means of promoting Indonesia's natural wealth that needs to be preserved and preserved at all times. The use of the magnetic pin is very easy, the magnetic pin is placed on the front of the jewellery (the round part that has depressions on the front and back) while the partner magnet is placed on the back so that the magnetic pin can stick to the jewellery.

Figure 10 Final Prototype
Source: Author's processing.

DISCUSSION

1. The use of natural finishing takes a longer time because it takes time for the finishing to seep into the pores. Based on the author's experience, 1 week is enough for the natural finishing set so that the finishing results can be used comfortably.
2. The shape of the jewellery needs to be considered because it affects the weight, asymmetrical jewellery is very prone to weight imbalance which when used will be heavy to one side so that it does not match the expected appearance and has the potential to make the user feel uncomfortable.
3. Bamboo coiling can still be further explored in terms of product form and variation.
4. Bamboo coiling has a similar technique to the lamination technique, where the bamboo slats are attached to each other, so the difference between the two is the roll. Bamboo coiling is made by rolling while lamination is only attached in parallel.

CONCLUSION

From this design, the following conclusions can be drawn regarding bamboo processing, coiling techniques and Gen Z preferences:

1. Bamboo is an organic material that is easily attacked by fungi and destructive organisms so that processing bamboo without preservation treatment will make the results less than optimal. Natural bamboo preservation can be done in several ways such as boiling, soaking, drying and so on. However, in this design, a boiling technique is used which successfully preserves the colour and condition of the bamboo slats.
2. Coiling can be made in any diameter with respect to the thickness of the bamboo, the thinner the bamboo slice the smaller the diameter that can be made.
3. Coating wood glue on the bamboo strips can make the fibres in the strips less prone to tearing.
4. Gen Z likes products that can be personalised and customised. Despite wanting to showcase their self-image through their appearance, based on the survey results, Gen Z

prefers medium to small-sized jewellery with natural colours even for certain occasions.

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THE IMPACT OF 3D PRINTING TECHNOLOGY ON TRADITIONAL JUN PORCELAIN SHAPING TECHNIQUES.

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Abstract

The purpose of this study is to investigate 3D printing technology and the traditional forming technique of Jun porcelain, with a view to exploring how 3D printers can be integrated into its original mold system through modernization instead of enhancing production efficiency at the manufacturing level while preserving the essence of authenticity in tradition. This study investigates the synergy of digital modeling and manual production with a novel design methodology balancing both tradition and innovation through literature review, case analysis, as well as experimental validation. An historical overview of Jun porcelain and traditional shaping prescribed by distinctive manual throwing and carving technologies The paper additionally highlights the advantages of 3D printing technology in ceramics: The advantages of 3D printing technology in ceramics include high-accuracy digital modeling, the ability to realize complex shapes, and the use of new materials. The findings indicate that 3D printing technology and traditional craftsmanship can enhance production efficiency without compromising artistic value. Additionally, digital design and rapid prototyping technology offer more efficient processes for the production of Jun porcelain, resulting in significant time and cost savings. This article also explores the preservation of Jun porcelain's cultural characteristics and artistic value through the application of modern technology. These results demonstrated the potential application of 3D printing technology in the molding of Jun porcelain, and they provided

programmatic guidance for its innovation in unconventional expression forms.

Key words: Jun porcelain, product design, 3D printing, traditional crafts

INTRODUCTION

Jun porcelain, a treasure of ancient Chinese ceramic art, dates back to the Song Dynasty and is world-famous for its unique kiln-fired glaze and superb potter's wheel carving techniques. Jun porcelain carries a profound cultural heritage and occupies a pivotal position in Chinese cultural history. Its colorful and unpredictable glaze perfectly blends nature and human ingenuity, and each piece is a unique work of art. (Chen et al., 2019) With the rapid development of modern technology, the traditional Jun porcelain craftsmanship is facing unprecedented challenges. The popularisation of mechanized production has improved production efficiency, but it has also caused some handicrafts to lose their unique charm and warmth. The problem of the lack of skills transfer is becoming increasingly prominent, and the younger generation's interest in ancient skills is gradually waning, putting traditional handicrafts such as Jun porcelain at risk of being lost. (Lai et al., 2024)

Figure 1. 3D printing equipment.

Against this backdrop, the rise of 3D printing technology

has brought new opportunities for the development of Jun porcelain art. 3D printing, as an additive manufacturing technology, can transform a designer's creative ideas into physical models with unprecedented accuracy and speed. (Chen & Almajed, 2022) In the field of ceramic art, 3D printing technology not only simplifies the complex process of traditional handicrafts and reduces production costs but also dramatically broadens the boundaries of design. Designers can use 3D modeling software to create more complex and detailed Jun porcelain shapes while retaining traditional Jun porcelain's artistic charm and cultural connotations. 3D printing technology also allows replicating and preserving Jun porcelain artworks. (Khorsandi et al., 2021) For some precious ancient Jun porcelain works, 3D scanning technology can accurately obtain their three-dimensional data and then use 3D printing technology to achieve high-precision replication, which satisfies people's need to appreciate ancient works of art and effectively protects the integrity of the original.

The historical and cultural value of the traditional Jun porcelain craftsmanship cannot be ignored, while the impact of modern technology has prompted us to find new development paths. The rise of 3D printing technology has provided new possibilities for the inheritance and innovation of Jun porcelain art. It not only makes up for traditional craftsmanship's deficiencies in efficiency and precision but also stimulates designers' creativity and promotes the development of Jun porcelain art in a more diversified and intelligent direction.

RESEARCH QUESTIONS AND OBJECTIVES

This study aims to explore in depth the profound impact of 3D printing technology on the modeling process of Jun porcelain. The specific objectives include three aspects. By carefully analyzing how 3D printing technology reshapes the art of modeling Jun porcelain, this paper hopes to reveal the potential of this modern technological means in enhancing the freedom of Jun porcelain design and achieving innovation in complex forms. With its high-precision digital modeling capabilities, 3D printing technology can accurately capture the designer's creative inspiration and transform complex line and

surface structures that are difficult to achieve in traditional handicrafts into reality, injecting new vitality into the art of Jun porcelain.

This research focuses on effectively preserving and passing on the essence of the traditional handicrafts of Jun porcelain by introducing 3D printing technology. The unique traditional techniques of hand-throwing, fine carving, and glaze color variation are indispensable to the unparalleled Jun porcelain. (Xue et al., 2023) Therefore, this paper needs to explore a balancing strategy that improves production efficiency and design flexibility using 3D printing without losing the cultural heritage and aesthetic value of Jun porcelain. This includes digitally recording and restoring the details of traditional craftsmanship and incorporating traditional elements into the design process to ensure that Jun porcelain works under the new technology can still carry the weight of history and the charm of culture. This study is dedicated to modernizing and efficiently transforming the Jun porcelain process. Faced with an increasingly competitive market environment due to globalization, the Jun porcelain industry urgently needs to enhance its competitiveness through technological innovation.

3D printing technology has brought revolutionary changes to Jun porcelain production thanks to its advantages of rapid prototyping, reduced material waste, and shortened production cycles. This article hopes to inject new vitality into the Jun porcelain industry and promote its development in a more intelligent and greener direction by optimizing the production process and improving production efficiency. This will also promote the widespread dissemination of Jun porcelain culture and enable more people to appreciate the unique charm of this ancient art form.

METHODS

This study adopts a multi-dimensional methodology to systematically explore the impact of 3D printing technology on the traditional modeling process of Jun porcelain. Through an extensive literature review, this paper traces the historical development of Jun porcelain, in particular the inheritance and development status of its unique hand-building and sculpting

techniques, as well as the challenges and opportunities these techniques face in the contemporary era. (Zhu et al., 2024) This paper provides an in-depth analysis of the latest developments in 3D printing technology in ceramic art, including research results in technical principles, materials science, and design innovation, laying a solid theoretical foundation for follow-up research.

This study designs detailed case studies, selecting several representative Jun porcelain creation projects at home and abroad, which all attempt to integrate 3D printing technology into the production of Jun porcelain. By comparing the traditional production methods with the production process assisted by 3D printing, this paper evaluates the advantages and disadvantages of the new technology in terms of modeling complexity, production efficiency, cost control, etc.

The case study not only focuses on the application results at the technical level but also explores in depth the impact of these changes on the artistic style and cultural heritage of Jun porcelain. In terms of experimental design, this paper designs a series of experiments to verify the feasibility and practicality of 3D printing technology in producing Jun porcelain. The experiments include constructing and optimizing digital models, producing 3D printed prototypes, subsequent processing, and final firing.

By comparing the experimental data, this paper quantifies how much the new technology has improved the modeling accuracy, material utilization, and production cycle of Jun porcelain. This paper also pays special attention to problems that may arise while applying new technologies, such as material compatibility and print accuracy control, and proposes corresponding solutions.

The innovation of this research lies not only in the discussion of technical aspects but also in the close integration of technology, art, and culture. It proposes a design methodology that modernizes and streamlines the process while retaining the essence of traditional Jun porcelain craftsmanship. (Zhang et al., 2023)

Through interdisciplinary collaborative research, this paper breaks down the boundaries between tradition and

modernity, providing new ideas and directions for the innovative development of Jun porcelain and ceramic art. This research also provides a valuable reference for the digital protection and inheritance of traditional craftsmanship. This study comprehensively and thoroughly explores the impact of 3D printing technology on the traditional modeling process of Jun porcelain through a combination of literature review, case analysis, and experimental design, providing strong theoretical and practical support for the modern transformation of traditional craftsmanship.

JUN PORCELAIN TRADITIONAL MODELING TECHNIQUES

Characteristics of the traditional modeling process of Jun porcelain

The traditional modeling process of Jun porcelain is deeply rooted in the essence of ancient Chinese ceramic art. Its uniqueness is first reflected in the hand-building and carving processes. As the primary technique for shaping Jun porcelain, hand-building requires the craftsman to rely on their rich experience and feel to place the wet clay on a rotating wheel. The basic shape of the vessel is then formed by squeezing and pulling with both hands. This process not only tests the craftsmanship level of the craftsman but also contains the pursuit and expression of beauty. Jun porcelain formed by throwing on a wheel has smooth and natural lines and a complete and rounded shape, demonstrating the craftsman's deep understanding and use of the material's characteristics. (Yu, 2018)

Carving is an integral part of the decorative art of Jun porcelain. They use techniques such as engraving, scoring, and picking; the craftsman carves various patterns and decorations into the formed body. These patterns include traditional themes such as dragons and phoenixes bringing good luck, peonies symbolizing wealth and prosperity, and landscapes, figures, flowers, birds, fish, and insects, which show the beauty of nature. Carving not only enhances the artistic expression of Jun porcelain but also enriches and diversifies its cultural connotations.

The charm of Jun porcelain lies in the variation of glaze

colors and firing techniques. Jun porcelain is known for its 'one color entering the kiln, a million colors emerging' effect, where the glaze colors change during the firing process due to the redox reaction and the subtle changes in temperature and atmosphere in the kiln, resulting in a kaleidoscope of colors. This unpredictability makes every piece of Jun porcelain a unique work of art. Jun porcelain is fired using traditional wood or coal-firing methods, and control of the fire is crucial – the slightest mistake could damage the piece. Therefore, the skill of the firing technique is directly related to the quality and value of the finished Jun porcelain. Jun porcelain also follows a series of aesthetic principles in the traditional process.

The first is the philosophical idea of 'unity of man and nature,' reflected in the pursuit of natural harmony in the shape and decoration of Jun porcelain, reflecting the intimate relationship between man and nature. The second is the artistic pursuit of 'expressing the spirit through form.' Through precise modeling and vivid decoration, the craftsman conveys the inner charm and emotion of the work. Jun porcelain also emphasizes 'exquisite craftsmanship and fine materials,' that is, the perfect combination of superb craftsmanship and high-quality materials, ensuring that the work has artistic beauty and practical function. (Chen, 2018) These aesthetic principles together constitute the unique charm of the traditional modeling process of Jun porcelain, giving it a pivotal position in the history of ceramic art in China and even the world.

The technical challenges of traditional craftsmanship

Although the traditional Jun porcelain modeling process carries a profound cultural heritage and artistic value, it inevitably faces technical challenges during hand-making. The limitations of hand-making lie in the difficulty of controlling production efficiency and consistency. Each piece of Jun porcelain is hand-thrown, carved, and fired by a craftsman. In this process, the skill level, emotional state, and even the day's environmental conditions can all subtly affect the final shape and quality of the work. According to statistics, an experienced artisan can only complete a few to a dozen pieces a day, and each piece is unique, making it challenging to meet the

standardization requirements of mass production. The inheritance and protection of the craft are facing a severe predicament. (Bose et al., 2024)

The Jun porcelain process is complex and delicate, and it takes years of learning and practice to master its essence. However, with the acceleration of the modernization process, the younger generation's interest in traditional handicrafts has gradually waned, and there are fewer and fewer people willing to devote themselves to the production of Jun porcelain. The transmission of traditional skills often relies on oral transmission from master to apprentice, and there is a lack of systematic written or video recordings, which poses a risk of a gap in the transmission of skills. As the older generation of craftsmen gradually ages, many unique skills and secret recipes may be in danger of being lost.

In order to address these challenges, in recent years, some Jun porcelain production areas have begun to try to introduce modern scientific and technological methods to the protection and inheritance of traditional craftsmanship. For example, by establishing digital archives, classic works can be scanned and modeled in three dimensions, and their forms and details can be preserved in digital form to provide intuitive information for future generations to learn and study. Education and training related to traditional craftsmanship have been strengthened. By establishing professional colleges and organizing skills training courses, more young people are attracted to Jun porcelain production, injecting fresh blood into the inheritance of the craft. (Li, 2023)

The government and all sectors of society have also increased their support for traditional craftsmanship. By setting up special funds, holding exhibitions and competitions, etc., the popularity and influence of Jun porcelain have been enhanced, and the public's interest and attention to traditional handicrafts have been stimulated.

APPLICATION OF 3D PRINTING TECHNOLOGY IN CERAMIC CRAFTSMANSHIP

Principles and characteristics of 3D printing technology

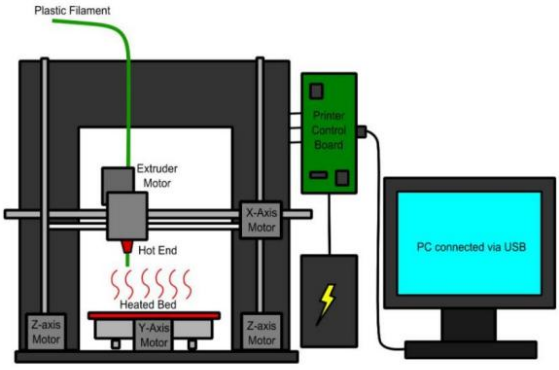

Figure 1. FDM technology, the principle of 3D printing technology

The core concept of 3D printing technology, or three-dimensional stereoscopic printing technology, lies in additive manufacturing, a very different manufacturing method from traditional subtractive or isometric processing. In additive manufacturing, an object is built up by accumulating material layer by layer, starting from the bottom and building up layer by layer until a complete three-dimensional solid is formed. This technology completely subverts traditional manufacturing thinking patterns and provides unprecedented flexibility and freedom for product design, manufacturing, and innovation. (Zhang et al., 2021)

In ceramic technology, introducing 3D printing technology has brought significant technological advantages. 3D printing can achieve precise manufacturing of complex structures. In traditional ceramic production, the shaping of complex forms often relies on the high skill of the craftsman, and there is a high failure rate. 3D printing technology, however, can directly print complex internal structures and delicate surface textures based on accurate 3D models generated by a computer, significantly broadening the boundaries of ceramic design.

3D printing technology has significantly improved the production efficiency of ceramic products. The traditional ceramic production process is cumbersome, involving multiple steps such as molding, grouting, trimming, and glazing, and is mainly done manually, which is time-consuming and labor-intensive. 3D printing, on the other hand, enables rapid

prototyping, significantly shortening the time from design to finished product. It is especially suitable for the production needs of small batches and multiple varieties. 3D printing also reduces material waste and efficiently uses resources by precisely controlling the material used in each layer.

3D printing technology also shows great promise in the application of ceramic materials. With the progress of material science, more and more ceramic materials have been developed, such as ceramic powders and pastes. These materials have good forming properties and meet different performance requirements. 3D printing technology can flexibly respond to the processing needs of these new materials, achieve diversified materials applications, and further promote the innovative development of ceramic technology.

3D printing technology, with its unique additive manufacturing principle, has demonstrated significant technological advantages in ceramic technology. It not only improves product design freedom and production efficiency but also promotes the diversified application of ceramic materials and injects new vitality into the innovation and development of ceramic art. (Lei & Mi, 2023) With the continuous maturity of the technology and the further reduction of costs, 3D printing technology is expected to play an even more critical role in ceramic technology.

The application of 3D printing technology in Jun porcelain

In the art of Jun porcelain, 3D printing technology has dramatically broadened the creative boundaries, especially in digital modeling, precision manufacturing, the realization of complex forms, and the exploration of new materials. Digital modeling technology provides unprecedented freedom for Jun porcelain design. With advanced CAD (computer-aided design) software, designers can construct any complex geometric shape or delicate artistic line precisely.

Everything can be precisely shaped in virtual space, from traditional bottles, cans, and dishes to highly modern abstract sculptures. (Lee et al., 2017) This process reduces the cost of trial and error in the design process and speeds up design

iteration, allowing Jun porcelain works to match the designer's creative vision more closely.

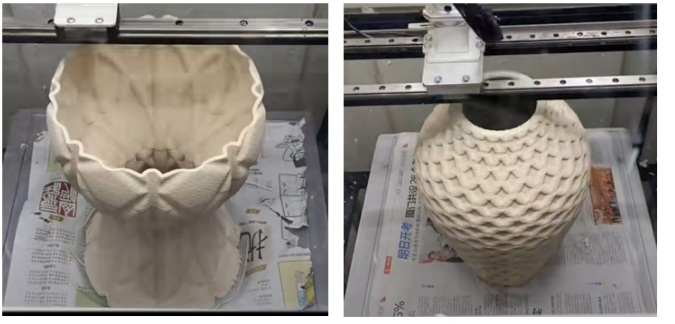

Figure 2. The application of 3D printing technology in Jun porcelain.

The precision manufacturing capabilities of 3D printing technology have enabled Jun porcelain to achieve new heights of precision in its shaping. Traditional hand-building is limited by the experience and skills of the craftsman, making it difficult to ensure complete consistency in each piece. 3D printing technology, on the other hand, directly replicates the design form precisely according to the digital model by layering materials and can achieve micron-level precision control of both the internal structure and external contours, ensuring the fineness and consistency of the work. 3D printing technology has also facilitated the creation of complex forms and structures in Jun porcelain.

Traditional techniques often face many challenges when creating complex shapes, such as constructing supporting structures and carving details. (Zhang & Liu, 2024) 3D printing technology can easily handle these challenges. It can directly print hollow, openwork, and multi-layered complex structures. It can even incorporate multiple materials and textures into the same work, greatly enriching the artistic expressiveness of Jun porcelain.

In terms of exploring and applying new materials, 3D printing technology has also injected new vitality into the art of Jun porcelain. With the advancement of science in ceramic materials, more and more new ceramic materials have been

developed. These materials have excellent physical properties and unique visual effects. (Li et al., 2023) 3D printing technology can flexibly use these new materials, and by precisely controlling the printing parameters, it can maximize the utilization of the material properties, bringing more possibilities to the creation of Jun porcelain. For example, some high-strength, low-shrinkage ceramic materials, with the support of 3D printing technology, can create more durable and versatile Jun porcelain works, further enhancing the artistic value and practicality of Jun porcelain.

The fusion of 3D printing and traditional craftsmanship

When exploring the fusion of 3D printing technology and the traditional modeling process of Jun porcelain, it is not difficult to discover that this is a profound and fruitful dialogue between modern technology and traditional craftsmanship. 3D printing technology, with its unique additive manufacturing method, has breathed new life and possibilities into the ancient art form of Jun porcelain. (Lin et al., n.d.) It is a technological innovation and a respect and extension of traditional craftsmanship.

Figure 4. The fusion of 3D printing and traditional handicrafts.

Modern technology, particularly the introduction of 3D printing technology, has opened up unprecedented flexibility and precision in the design and production of Jun porcelain. Designers can use 3D modeling software to convert complex creative ideas into digital models, which can be accurately reproduced using a 3D printer. This process dramatically

shortens the distance from design to reality and no longer restricts Jun porcelain modeling to traditional hand-building techniques. Digital technology also provides strong support for traditional handicrafts. In producing Jun porcelain, changing the color of the glaze and the firing process are highly critical. Traditional glaze color matching and firing experience often requires years of accumulation and exploration by artisans. (Maurath & Willenbacher, 2017)

Nowadays, with the help of modern scientific methods such as spectral analysis and thermal imaging, the laws of glaze color changes and firing conditions can be more scientifically understood, providing a scientific basis for innovation in Jun porcelain glaze colors. 3D printing technology can also be used to create precise molds, helping artisans better control the shape and size during the firing process and improve the yield of finished products. 3D printing technology has not replaced traditional handicrafts but has formed an excellent complementary relationship with them.

In the creation of Jun porcelain, many artists still insist on the steps of hand-carving and decoration to show its unique artistic charm and cultural connotations. 3D printing technology is more commonly used in areas such as prototype making and the construction of complex structures, providing traditional handicrafts with a broader creative space and technical support. (Wang et al., 2023) The integration of 3D printing technology and the traditional modeling process of Jun porcelain has not only improved the efficiency and precision of Jun porcelain production but also injected new creativity and vitality into it. This integration is a form of inheritance and development of traditional handicrafts and an active exploration and practice of combining modern technology with traditional culture.

THE IMPACT OF 3D PRINTING ON THE TRADITIONAL MODELING PROCESS OF JUN PORCELAIN

The freedom and innovation of modeling design

When discussing the impact of 3D printing technology on the traditional modeling process of Jun porcelain, one significant change is the significant increase in modeling complexity brought about by digital modeling. In traditional Jun

porcelain production, the shape relies heavily on the craftsmanship and experience of the artisan. Limited by physical manipulation and the characteristics of the material, complex and detailed designs are often difficult to achieve.

In contrast, 3D printing technology can easily create highly complex and precise 3D models through high-precision digital modeling software. These models can be repeatedly modified and optimized on a computer to ensure a high degree of restoration of the final product. (Xu, 2024) This seamless conversion from 2D design to 3D entity has dramatically broadened the boundaries of Jun porcelain modeling design, allowing designers to break through the limitations of traditional craftsmanship and realize more complex and ever-changing artistic concepts.

Figure 5. The freedom and creativity of 3D printing in design

Digital modeling technology allows Jun porcelain works to incorporate modern and geometric aesthetics to create unprecedented forms and structures. For example, using 3D modeling software, it is possible to design complex structures such as multi-layer nesting and hollow engraving, which are difficult to achieve in traditional hand-building. These designs not only enhance the work's visual impact but also enrich the artistic expression of Jun porcelain. Digital modeling has also promoted the cross-border integration of Jun porcelain with other art forms, such as architectural design and sculpture, to create Jun porcelain artworks with unique styles.

The application of new technologies in innovative design is also evident. 3D printing technology has brought unprecedented flexibility to Jun's porcelain design. Designers can freely explore various design possibilities in virtual space without worrying about technical difficulties in actual production. This increased freedom of design has stimulated the creativity of designers and promoted the development of Jun porcelain art in a more diversified and personalized direction. (Huang & Chen, 2024) Combining virtual reality (VR) and augmented reality (AR) technologies, designers and consumers can also preview and experience design results in a virtual environment, further enhancing the interactivity and sense of participation in the design.

3D printing technology has revolutionized the traditional modeling process of Jun porcelain by improving modeling complexity through digital modeling and applying new technologies in innovative design. It not only broadens the boundaries of design but also stimulates the creativity of designers and promotes the innovative development of Jun porcelain art. In the future, with the continuous advancement of technology and in-depth application, there is reason to believe that Jun porcelain art will shine even brighter at the intersection of tradition and modernity.

Process optimization and efficiency improvement

The introduction of 3D printing technology has significantly optimized the process of making Jun porcelain, enabling rapid prototyping from design to finished product and significantly promoting the diversification and flexibility of production. In traditional Jun porcelain production, from hand-building and sculpting to firing, each process consumes a lot of time and workforce, and the yield is affected by many uncontrollable factors. (Zhang & Zhang, 2024) In contrast, 3D printing technology directly converts designs into three-dimensional physical models through high-precision digital modeling, eliminating cumbersome manual production steps and significantly shortening the cycle from design conception to physical verification. 3D printing technology allows designers to create prototypes of multiple design options quickly. These

prototypes accurately reflect the design intent and can be quickly adjusted and optimized in subsequent stages, reducing material waste and production costs caused by improper design. According to industry reports, after adopting 3D printing technology, the iteration cycle of Jun porcelain design can be shortened to one-fifth of the traditional method, significantly improving design efficiency and market response speed. 3D printing technology has also promoted the diversification of Jun porcelain production. (Owen et al., 2018)

Traditional handicrafts are limited by the skill level and experience of the craftsman, making it difficult to achieve complex and ever-changing shapes and pattern designs. 3D printing technology, on the other hand, can easily handle the challenges of various complex forms and perfectly reproduce fine textures, unique shapes, and precise dimensional control. This ability allows Jun porcelain works to break through traditional boundaries and develop in a more personalized and artistic direction.

3D printing technology also shows excellent advantages in terms of production costs. Although the initial equipment investment is high, its long-term cost-effectiveness gradually becomes apparent as the technology becomes more widespread and economies of scale are achieved. In small-batch, customized production, in particular, 3D printing technology effectively reduces production costs by reducing the need for mold making and lowering the rate of rejects.

Due to the shortened production cycle, companies can recover funds more quickly and invest in the next round of production, further improving capital utilization efficiency. (Wang et al., 2024) The application of 3D printing technology in the production of Jun porcelain optimizes the process flow, improves production efficiency, and promotes the diversification of designs and personalization of production. These advantages have jointly promoted the transformation and upgrading of the Jun porcelain industry and opened up new paths for the modern development of traditional handicrafts.

Preserving and passing on the essence of traditional craftsmanship

When discussing the impact of 3D printing technology on the traditional modeling process of Jun porcelain, the central position of traditional craftsmanship should be considered. Jun porcelain is a treasure of Chinese ceramic art; its unique hand-throwing and sculpting techniques carry thousands of years of cultural accumulation and the spirit of craftsmanship. Under the impact of the modern technological wave, although 3D printing technology is known for its high precision, high efficiency, and design freedom, the cultural value, artistic charm, and irreplaceable manual warmth inherent in traditional handicrafts are still difficult to completely replace by any modern technology. (Jing, Cheng, Xu, & Zhu, 2023)

In order to effectively preserve and pass on the essence of the traditional Jun porcelain craftsmanship, the key lies in strategic integration and innovation. On the one hand, traditional craftsmanship's aesthetic principles and essence should be explored in depth, such as the natural kiln changes of glaze colors and the feel and strength control when throwing on the potter's wheel. These unique artistic languages must be passed down through master-apprentice teaching and on-site demonstrations to ensure the continuity and purity of the craftsmanship. (Buj-Corral & Tejo-Otero, 2022)

On the other hand, digital recording and replication using 3D printing technology can accurately capture and preserve every detail of traditional shapes, providing valuable information for future generations to learn and study. While retaining traditional elements, the harmonious coexistence of tradition and modernity can be achieved by integrating 3D printing technology into the creation of Jun porcelain through innovative design techniques. For example, 3D printing technology can be used to create complex and detailed molds to assist in the manual completion of difficult-to-achieve modeling parts in the throwing or carving process, which not only retains the warm and tactile feel of handicrafts but also expands the boundaries of design. Through 3D modeling technology, traditional patterns can be combined with modern design concepts to create new works that conform to modern aesthetics and are rich in cultural heritage. In preservation and inheritance, we also need to pay attention to intellectual

property protection and the establishment of cultural confidence. (Chi, 2023)

Strengthening the intellectual property protection of traditional Jun porcelain craftsmanship and preventing the loss of skills and commercial abuse is an important guarantee to ensure the sustainable development of traditional craftsmanship. Through cultural exchanges and exhibitions at home and abroad, the unique charm of Jun porcelain art is showcased, enhancing confidence and pride in national culture and allowing more people to understand and value this valuable cultural heritage. (Yang, Li, & Mu, 2024) The preservation and inheritance of the essence of traditional handicrafts requires us to make flexible use of modern scientific and technological methods based on respect and inheritance, to achieve an organic integration of tradition and modernity, and to enable Jun porcelain, an ancient art form, to shine even brighter in the new era.

Experimental verification and case analysis

This paper conducts a series of experiments to explore in depth the specific impact of 3D printing technology on the traditional modeling process of Jun porcelain. It analyzes the Jun porcelain 3D-printed works produced during the experiments. These experiments cover the entire process from design, modeling, and printing to post-processing but also focus on comparing the differences and integration of traditional craftsmanship and modern technology.

Figure 6. 3D printing experimental process.

In the experimental stage (Figure 6), this paper selected a representative Jun porcelain shape as a prototype, used 3D scanning technology to obtain its precise 3D data, and optimized and innovatively designed it in professional 3D design software. By adjusting design parameters such as curvature, thickness, and internal structure, complex forms that are difficult to achieve using traditional techniques, such as fine openwork carving and variable surface structures, were successfully realized. These designs retain Jun porcelain's charm and add a modern and artistic feel. (Peng et al., 2024)

In the printing process, this paper selects 3D printing technologies suitable for ceramic materials, such as ceramic slurry injection (CIP) or sintering of ceramic powders (SLS), to ensure the accuracy and strength of the printed work. This paper obtains Jun porcelain blanks with smooth surfaces and dense structures by precisely controlling printing parameters such as layer thickness, sintering temperature, and speed. Compared with traditional hand-throwing, 3D printing technology significantly improves production efficiency and the body's uniformity and reduces the reject rate. (Yan, 2024)

In terms of successful cases, this paper designs and prints a series of innovative Jun porcelain works, such as a tea set with modern geometric elements and a vase with complex pattern decorations. These works have won wide acclaim in the industry for their unprecedented beauty of form and structure while maintaining the unique glaze color changes of Jun porcelain. In particular, the delicate carvings and complex structures achieved using 3D printing technology have become a highlight of the works. However, there were also challenges and failures in the experimental process.

For example, when trying to print Jun porcelain shapes with extremely high curvature changes, some works cracked or deformed due to problems with material fluidity and shrinkage problems. The even distribution and adhesion of the glaze layer on the printed blank body have also become one of the technical difficulties. (Li & Cheng, 2024) In response to these problems, this paper has repeated experiments and adjustments, gradually optimizing the printing process and post-processing

procedures, providing valuable experience for future applications.

Through this experimental verification and case analysis, this paper has gained a deep understanding of the great potential and challenges of 3D printing technology in the traditional Jun porcelain modeling process. In the future, we will continue to explore more possibilities, promote the deep integration of traditional craftsmanship and modern technology, and inject new vitality into the development of Jun porcelain art.

CONCLUSION

This study explores in depth the profound impact of 3D printing technology on the traditional modeling process of Jun porcelain. Specifically, 3D printing technology, with its unique additive manufacturing approach, significantly enhances the freedom and precision of Jun porcelain modeling and design. Through high-precision digital modeling, designers can create more complex and detailed Jun porcelain forms, broadening the artistic expression of Jun porcelain and satisfying the modern aesthetic pursuit of personalization and differentiation. For example, some complex geometric patterns and streamlined designs are challenging in traditional hand-building, but 3D printing technology can easily handle them, injecting new vitality into Jun porcelain art.

The introduction of 3D printing technology has dramatically improved production efficiency in terms of the production process. The rapid prototyping capability allows designers' ideas to be quickly transformed into physical objects, significantly shortening the cycle from product design to market. By reducing manual operations, production costs are also effectively controlled. 3D printing technology shows excellent advantages, especially in small-batch, customized production. 3D printing technology also enables precise use of materials and reduces waste, aligning with sustainable development.

The study also emphasizes the importance of maintaining respect for the essence of traditional craftsmanship in modernizing the Jun porcelain process using 3D printing

technology. The unique charm of Jun porcelain lies not only in its exquisite appearance but also in its profound cultural heritage and the emotional investment of the artisans. Therefore, when introducing new technology, attention should be paid to integrating traditional techniques. Through interdisciplinary cooperation, a design methodology can be explored that not only gives full play to the advantages of 3D printing technology but also retains the essence of traditional craftsmanship. For example, 3D printing technology can be used to create the complex structural parts of Jun porcelain, while critical processes such as color variation and firing can still be completed manually by experienced craftsmen.

This not only ensures the artistic and unique nature of the product but also improves production efficiency. 3D printing technology has brought unprecedented opportunities for change to the traditional modeling process of Jun porcelain, but it has also presented new challenges. In future development, the concept of 'technology empowerment and culture as the soul' should be upheld, and the path of integration of new technologies and traditional craftsmanship should be continuously explored to achieve innovative development of Jun porcelain art.

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THE UTILIZATION OF SEA GLASS AS AN ATTRACTIVE MATERIAL IN JEWELRY WITH A KINTSUGI APPROACH

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Abstract

One of the significant contributors to environmental pollution is waste from glass bottles. A potential solution to this problem is transforming glass into sea glass, consisting of glass shards that are naturally recycled by the ocean over 5 to 50 years, smoothing sharp edges. Unlike plastic, which breaks down into microplastics, the sea can recycle glass due to its high pH and the presence of sand and rocks that aid in the smoothing process. Sea glass has a positive environmental impact as a recycled material that can replace new raw materials. This study aims to develop jewelry from sea glass using the kintsugi technique, which combines glass fragments with precious metals to create aesthetic and economic value products. The research identifies market needs for attractive and sustainable jewelry through in-depth interviews with respondents. The analysis results indicate that the jewelry developed will comprise a necklace, ear cuff, and bracelet set. Therefore, developing sea glass-based jewelry using the kintsugi technique is expected to contribute to environmental preservation while enhancing the competitiveness of domestic jewelry products in the global market.

Key words: waste, Sea Glass, Jewelry, Kintsugi, culture, exploration

INTRODUCTION

Cindy Mutia Annur (2023) noted that glass waste is one of the highest contributors to environmental pollution, reaching up to 304,330 units. In single-stream recycling systems, glass increasingly becomes a contaminant, as glass shards can pollute other recyclable materials. One effort to recycle glass shards

without causing contamination and ensuring greater safety is by transforming them into sea glass. Sea glass is a naturally recycled form of glass that is shaped by the ocean over many years into beautiful stones. This process can take about 5 to 50 years, smoothing the sharp edges of glass shards due to the high pH of seawater, which can naturally recycle glass. The presence of coarse sand and numerous rocks aids in transforming sharp-edged glass fragments into smooth surfaces. The smaller and smoother the sea glass found on the beach, the longer the recycling process has taken, which also increases its market value. (Anwar & Hasan, 2021)

There is an effort to create sea glass using a machine. This process utilizes a rock tumbler, which serves as an alternative method for producing sea glass by significantly shortening the natural weathering process that typically takes a long time when done through seawater. This method is more efficient, and the potential for developing sea glass using a rock tumbler also contributes to environmental preservation, as it is part of the effort to recycle glass bottle waste. (*What is the Environmental Impact of Sea Glass?*, n.d.) The recycled sea glass will be approached using the kintsugi technique, which represents cultural value in relation to the philosophy of kintsugi. This will also enhance the aesthetic value of sea glass as an attractive material in jewelry. (Simanungkalit, 2018)

This research is conducted to address three main research questions: 1) Designing sea glass as the primary material for jewelry products using a rock tumbler with the kintsugi technique. 2) Designing sea glass jewelry products to ensure environmental value and promote sustainability. 3) Designing sea glass into jewelry products that reflect distinctive features of Indonesian culture. The research is limited by: 1) The dimensions of the resulting sea glass will vary and not be identical. 2) The color of the sea glass will be limited. 3) The target users for this design are female jewelry consumers in Indonesia, aged 25 to 33 years.

1. Standardization of Glass Bottles and Jars

According to the Indonesian National Standard (SNI) 8229:201X, regarding glass bottles and jars, it establishes

quality requirements for glass bottles with narrow-necked containers that must meet the following quality criteria: (National Standardization Agency of Indonesia, n.d.)

a. The visible quality
   The visible quality of glass bottles and jars, when tested for use by the general public as food or beverage packaging, must not have any defects, including critical defects, severe functional defects, or minor functional defects.
b. Dimensions and Tolerances
   Dimension and tolerance testing is conducted on five test specimens. If there are dimensions for the glass jars being tested, they must meet tolerance requirements for capacity, nominal height, nominal diameter, verticality, and the lack of parallelism of the ends, referring to the base of the container.
c. Temperature shock
   Temperature shock testing is conducted on five test specimens. Glass bottles and jars intended for food and beverages must not crack or break. The requirement for the temperature difference of the beverage is 42 degrees Celsius, with a low temperature of approximately 22 degrees Celsius, allowing for a variation of about 5 degrees Celsius.
d. Internal Pressure
   Pressure glass bottles must meet the quality requirements for pressure as specified in the table below.

Table 1 – Internal Pressure
Source: National Standardization Agency of Indonesia, 2024

Type of Bottle	Single-Use (kgf/cm^2)	Reusable (kgf/cm^2)
Carbonated Non-Alcoholic Beverages	12,3	14,1
Carbonated Alcoholic Beverages	12,3	14,1
Fermented Beverages	14,1	-

e. Vertical Load Resistance
   The quality standards for glass bottles and jars for food and beverages must meet a vertical load resistance of at least 3000 N.

f. Alkali Migration
The limit for alkali migration in glass bottles and jars, when tested, must meet the following requirements.

Tabel 2 – Maximum Alkali Migration Limits
Source: National Standardization Agency of Indonesia, 2024

No.	Substance	Maximum Migration Limit in Glass Containers (x 10^{-6} mg/L)
1.	Alkali (Na/K)	8,50
2.	Lead (Pb)	0,50
3.	Cadmium (Cd)	0,50

g. Annealing Stress
The annealing stress requirement for glass bottles and jars for food and beverages must not exceed a maximum of 4 standard stress pieces.
h. Impact Resistance
The minimum impact resistance requirement for glass bottles and jars for food and beverages is 3.5 kgf/cm^2.

2. Characteristics of *Sea Glass*

Sea glass generally has a smooth and hard surface, and it becomes more opaque over time. Sea glass that undergoes the weathering process will experience a reduction in dimensions from the original glass shards before weathering. In terms of color, the most common sea glass colors are white, brown, and green, as these colors are typically derived from milk bottles, syrup bottles, or beer bottles. Other colors are relatively rare because their usage is less common compared to these three colors. (*Sea Glass*, n.d.)

3. Kintsugi *Technique*

Kintsugi originating from *Kin* (金) is gold, whereas *tsugi* (継ぎ) is a method of repairing ceramics or fragile items using a special adhesive mixed with gold, silver, or platinum. It is based on an appreciation of the object's history, acceptance of flaws, imperfections, and the aging process.

Figure 1. Kintsugi
Source: Risner, 2022

This technique, which originated in Japan, emerged when a ceramic item was accidentally broken and then repaired in a more elegant and aesthetic manner using molten gold powder to fill each crack. The process of creating kintsugi ceramics involves using a special ceramic adhesive, which is then enhanced with authentic gold powder for aesthetic appeal. Generally, objects that undergo kintsugi treatment end up as decorative home items. (Simanungkalit, 2018)

RESEARCH METHODS

This research method involves analyzing the study subjects, specifically targeting users who have an enthusiasm for fashion jewelry that embraces the concept of sustainable jewelry and belong to the upper-middle class. The research is conducted through material exploration of sea glass, incorporating the additional technique of Kintsugi.

The research flow is as follows: 1) Analyzing the problems identified by the researcher. 2) Collecting data using literature review methods, in-depth interviews with two study subjects, and a questionnaire distributed to respondents who meet the study specifications. 3) Exploring materials related to the research.

1. Jewelry

   In general terms, jewelry can be defined as an item worn to enhance one's appearance, whether for special occasions or everyday use. Jewelry is not just an accessory for users to look more beautiful or stylish; it can also signify the social

status of the person wearing it. This is evidenced by the discovery of jewelry in ancient times, which was not only used to adorn the body or clothing but also held significant functions and meanings for specific groups or tribes. The experimentation process occurs after analyzing data related to jewelry users. The experiments are conducted based on key points that are important considerations for this design. (Arumsari, n.d.)

2. Processing of Sea Glass Materials

The primary material is the central element of a product. It serves as the focal point that highlights the product. In this research, sea glass is the main material. Generally, sea glass has a smooth and hard surface, and it becomes more opaque over time. Sea glass that undergoes the weathering process will inevitably experience a reduction in dimensions from the original glass shards.

In terms of color, the most common sea glass colors are white, brown, and green, as these colors are typically derived from milk bottles, syrup bottles, or beer bottles. Other colors are relatively rare because their usage is less common compared to these three. (*How to Make Sea Glass with a Rock Tumbler*, n.d.) The process of processing sea glass is a manufacturing analysis study conducted through direct research.

a. Collection of glass bottle waste: The process begins with the collection of glass bottle waste from collectors. The gathered shards consist of various shapes, colors, and sizes.
b. Breaking glass bottle waste: This process involves cleaning the bottles to remove any labels still attached to the surface. The cleaned used glass bottles are then inspected and sorted by thickness and color. After that, the glass bottles are broken using a hammer and thick cloth.
c. Grinding process using a rock tumbler: This process involves mixing materials such as sandpaper powder, polishing powder, and water into the rock tumbler along with the previous glass shards. One rock tumbler can accommodate the volume of shards from one large glass

bottle. This process can take several days to achieve the perfect sea glass results.

d. Checking the sea glass: This process is carried out multiple times to ensure the sea glass reaches perfection. If the sea glass is not yet fully formed—meaning the surface is not smooth and the color has not changed—the grinding process can be repeated until the desired results are achieved.
e. Washing the sea glass: The formed sea glass is then cleaned of any remaining material residues.
f. Selecting the sea glass: This process aims to sort the sea glass shards based on dimensions, ensuring they are suitable for use in necklaces, bracelets, rings, or other types of jewelry.

Figure 2. Processing Sea Glass with a tumbler rock glass
Source: Author's Processing, 2024.

3. User Study

The study on jewelry users employs in-depth interviews and user preferences. The research aims to understand tastes in jewelry products, which will later be implemented in the study. The study focuses on potential users aged approximately 25 to 35 years. Participants were selected based on their relevance to the research, specifically targeting those living in urban areas. The chosen demographic consists of women aged 25 to 33 who wear jewelry in their daily activities and have an income above 4,000,000, placing them in the upper-middle class. All participants expressed interest in a feminine look, as this style aligns with their attendance at significant events. However, they

prefer a design that combines traditional elements with modern adaptations. The participants agreed to select floral motifs as supporting designs for this research product, with the chosen flower being the frangipani.

4. *Kintsugi* Analysis

   In this Kintsugi experiment, the author focuses on the appearance of the sea glass jewelry to enhance its appeal to users, thereby increasing the value of the jewelry product. During this experiment, several color combination processes were conducted to support the successful treatment of sea glass using the Kintsugi technique.

Table 3 - Results of Sea Glass Type Collaboration Using Kintsugi
Source: Author's processing, 2024

No.	Parameter	Type of Sea Glass Kintsugi Combination	Difficulty Level	Neatness Level
1.	Ease and neatness of applying the kintsugi technique on sea glass with different .	 2 colors and 2 thicknesses	Difficult Reason: The difference in glass thickness prolongs the glass joining process.	Low Reason: The difference in glass thickness makes it difficult to create a level surface.
2.	Ease and neatness of applying the kintsugi technique on sea glass with different.	 3 colors and 2 thicknesses	Very Difficult Reason: The difference in glass thickness and types prolongs the glass joining process.	Low Reason: The difference in glass thickness makes it difficult to create a level surface.
3.	Ease and neatness of applying the kintsugi technique on sea glass with the same.	 1 color and 1 thickness (thin)	Easy Reason: The same thickness and type of glass (thin) speeds up the glass joining process.	Neat Reason: The same thickness of glass (thin) makes it easy to create a level surface.
4.	Ease and neatness of applying the kintsugi technique on sea glass with the same	 1 color and 1 thickness (thick)	Very Easy Reason: The same thickness and type of glass (thick) further speeds up the glass joining process.	Very Neat Reason: The same thickness of glass (thick) makes it easier to create a level surface.

The author obtained data from the analysis of color combinations and thickness, as shown in the table above. It was found that different thickness combinations present a higher level of difficulty; however, the color combinations resulted in an appealing visual value when paired together. Thus, the author concludes that while combining colors, if there is variation in thickness, additional layers need to be applied to the sea glass to enhance its neatness, allowing it to be processed into the design product in the next stage.

5. Material Exploration

   In the initial manufacturing process of kintsugi sea glass, the sea glass is bonded using epoxy glue, which serves as the primary material in the kintsugi process. The adhesion process must be carried out quickly by mixing the epoxy glue in a 1:1 ratio with the hardener, which is then applied to each piece of sea glass individually.

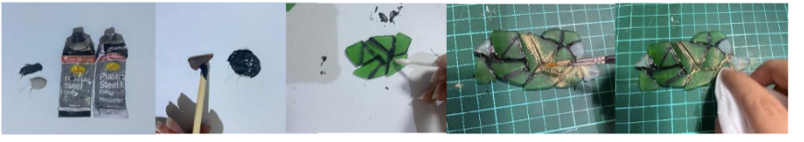

Figure 3. Kintsugi Sea Glass Stone Assembly Process
Source: Author's processing, 2024.

After the adhesive is applied, while it is still partially wet, gold powder is sprinkled on it and left to dry. Once dry, the area with the gold powder is tidied up using a damp tissue. Below are the results of the sea glass that has undergone the kintsugi process; this glass will eventually be assembled as the main stone in the jewelry product using a bezel setting.

Figure 4 – Sea Glass Kintsugi
Source: Author's processing, 2024.

RESULT

The final stage involves selecting the final design for a set of jewelry that will move on to the manufacturing phase. Each design in this set has its own concept, derived from the overarching concept of the Nusantara Series established earlier. The Nusantara Series draws inspiration from the rich natural resources found in Indonesia.

Osa Series, This jewelry series features green sea glass combined with black and white sea glass. It is named “Osa,” which means “growth” in Sanskrit, representing the natural growth of plants. This reflects the predominant green color of the sea glass, which embodies the personalization of botanical elements.

Figure 5. Visualization of the sea glass kintsugi jewelry set
Source: Author’s Processing, 2024.

DISCUSSION

1. The shape of the jewelry is important because it affects the weight; asymmetrical jewelry is very susceptible to weight imbalance, which can cause it to feel heavy on one side when worn. This results in a look that is not as intended and may make the user feel uncomfortable.
2. Kintsugi adhesion is performed with safety in mind, as it uses a strong adhesive, epoxy glue. Based on the author's experience, it is necessary to wear a mask to avoid the unpleasant odor of the epoxy during the adhesion process, which also requires a lengthy duration to set properly.
3. The sea glass pieces to be bonded must have the same thickness, as differing weights can affect the balance of the kintsugi sea glass.

CONCLUSION

Sea glass is a naturally recycled form of glass that has been shaped by the ocean over many years into beautiful stones. This process can take between 5 to 50 years, smoothing the edges and corners of glass shards. Unlike plastic waste, which breaks down into microplastics, seawater can "recycle" glass shards into stunning glass stones. The smaller and smoother the sea glass found on the beach, the longer the recycling process has taken, which also increases its market value. Seawater has a high pH level, enabling the natural recycling of glass, while coarse sand and numerous rocks aid in transforming sharp glass fragments into smooth surfaces. In this study, material exploration of sea glass is conducted with a focus on the appearance of the jewelry pieces to enhance their appeal, thereby increasing the value of the jewelry products.

The research includes several processes of color combination exploration that support success in terms of appearance. This results in sea glass being transformed into gemstones by incorporating the kintsugi technique, which uses a special adhesive mixed with gold. Additionally, the limited exploration of design in this area presents a significant opportunity for developing jewelry with sea glass materials, allowing for further exploration into other products that cater to the preferences of future generations.

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APPLYING DESIGN THINKING TO DEVELOP INTERACTIVE HOTEL AMENITIES: A CASE STUDY OF UNWIND

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Abstract

This study explores the application of Design Thinking in developing UNWIND, an interactive wall game designed to improve hotel amenities by combining art, play, and tourism. By employing the Design Thinking approaches that comprise the stages of "Empathize", "Define", "Ideate", "Prototype", and "Test", this study demonstrates how guest-centric innovation can redefine hospitality experiences. During the early process, the needs and preferences of hotel guests were identified through empathy-driven research, leading to the design concept of multifunctional products that serve as a decorative art piece and an engaging, interactive game that 3-4 people can play. The ideation and prototyping phases focused on function, user experiences and unique features, resulting in UNWIND being interactive, fulfilling user needs, and educating users about Malaysian tourism landmarks. The findings suggest that employing design thinking can drive innovation in the hospitality industry, offering prospects for premium tourist items that blend function and engagement. UNWIND sets a new benchmark for hotel wall decoration, providing an interactive and transformative user experience beyond traditional amenities and enhancing hotel and guests' value proposition.

Key words: design thinking, user centered design, interactive design, Hotel Amenities.

INTRODUCTION

The hospitality industry has undergone some significant

changes over the past couple of decades in response to the growing demand for enhanced guest experiences and a wider range of offerings in an increasingly highly competitive market. In the 1980s, the industry saw a rise in boutique lifestyle hotels, which led to changes in what the guests expected during their stay at the hotel. (Chen & Chen, 2022; Ju, 2019; Kim et al., 2017) Larger hotel chains have taken steps to provide guests with curated, memorable experiences to adapt to the guests' needs, wants and preferences. Because of these changes, many hotels feel the pressure with the need to offer more and more amenities for the sake of keeping their guests satisfied. According to Chen & Chen (2022) and Ju (2019) due to limited funds, most of the hotel management need to carefully consider and select their offering the guests wisely in order to make the most of their offer to provide a sufficient experience to the guests.

New trends and developments in this scenario constantly affect the global industry. Nowadays, the classic room facilities and amenities have become more modern, personalised, and guest-friendly, and they are located in a calm environment. This shift reflects the industry's recognition of the need to adapt to the changing consumer preferences and to focus on providing a unique, diverse range of services and amenities to cater for the broad spectrum of consumer needs. (Chen & Chen, 2022; Ju, 2019; Kim et al.,2017) Conventional and classic amenities, such as air conditioning, soundproofing, safety box, hair dryer, mini refrigerator, clean towels & linens, free self-care products, toiletries, slippers, ironing board, kettle, telephone and television, are no longer sufficient to capture the attention and satisfaction of today's travellers who seek personalised interactions during their stay at the premises.

In response, it can be seen that there is a growing trend towards interacting with multifunctional and interactive elements in hotel spaces that go beyond conventional, aiming to provide guests with unique and immersive experiences. With today's competitive hospitality industry, with the large number of new hotel brands that offer diverse offerings and the advancement of technology, it can be difficult for the hotel to

stand out in the eyes of the hotel guests. Renovating the property to improve the facilities is too costly and time-consuming; the better alternative for the hotel to compete is to invest in hotel amenities, which offer a simple yet impactful way to stand out among other hotels in the market. (Kim et al.,2017; Pugachov, et al., 2022)

Hotel amenities play a crucial role in shaping the guests' experiences, as most guests crave something distinctive, unique, full of surprises and engaging during their stay. (Ju, 2019; Kim, 2017) These amenities range from personalised welcome gifts and locally sourced toiletries to unique experiences such as honeymoon or birthday celebrations, guided tours or cooking classes. Some hotel amenities are designed for the guests to take back as mementoes and souvenirs as evidence of their special moments during their stay. This concept of amenities will create meaningful experiences and encourage the guests to revisit or recommend the hotel to other people. (Chen & Chen, 2022; Kim, 2017)

To keep pace with these emerging trends, this study investigates the application of design thinking in developing hotel amenities products, highlighting how this user-centred approach can drive innovation in creating premium tourist items that can entertain, educate, and engage people. Design Thinking, emphasising empathy, creativity, and iterative testing, offers an approach to understanding people's needs, leading designers to create meaningful solutions. (Brown, 2008; Dell'Era, et al., 2020; Cross, 2023) According to Brown (2008) and Cross (2023), by implementing this methodology in the design process, final product outcomes will transform people's experiences that combine functionality, aesthetics, and also cultural significance.

Aims & Objectives

The primary aim of this study is to explore the application of Design Thinking in the product development of hotel amenities, specifically the case study of UNWIND, the interactive wall game that combines art and play. This study seeks to discover how design Thinking approaches can be utilised in

design development to create user-centered products that will enhance user experiences through the stages of the Design Thinking process. (Brown, 2008; Dell'Era et al., 2020; Cross, 2023)

Through the stages of "Empathize", "Define", "Ideate", "Prototype", and "Test" this study will provide insights into the development of innovative hospitality product solutions that will cater for the evolving of modern travellers. The objectives of this study are: (i) To explore the potential of Design Thinking in driving future innovations in premium tourist items within the hospitality sector and (ii) To understand User needs and preferences regarding interactive and engaging in-room hotel amenities that contribute to guest satisfaction and enhance user experiences.

RESEARCH METHODS

This study employs a Design Thinking approach adapted from Brown, (2008), Dell'Era et al., (2020); Cross, (2023) and Robinson, (2023) to explore the development of UNWIND, an interactive wall game designed for hotel rooms. The research methodology follows the five stages of the Design thinking process, as shown in Figure 1. This iterative design thinking process was chosen to ensure the final product's outcome meets users' needs and expectations. The visual flow in Figure 1 represents the iterative and user-centred nature of the Design Thinking process embedded in the study.

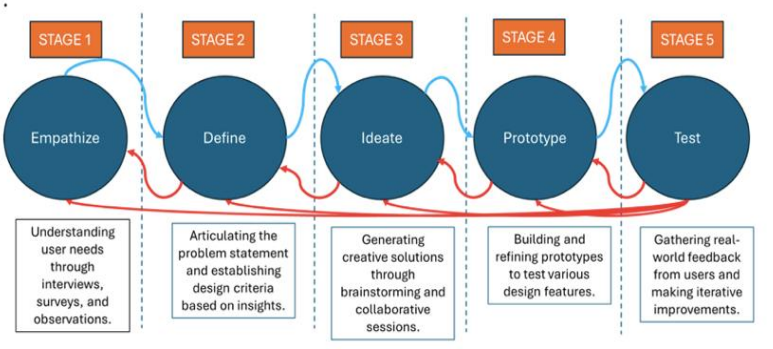

Figure 1. Overview of how the Design Thinking process used in this study.

Stage 1 Emphasize: Understanding User Needs

This first stage involved six family guests of hotel customers at the Grand Ion Element, Genting Highland, Malaysia. The researcher used face-to-face, in-depth interviews, probing techniques and observational studies (Cerci, 2024; Henriksen, et al. 2017) to identify how the guests interact with existing room features and amenities. The interview script was developed to gain a deeper understanding of user needs, desires, challenges, and issues faced by hotel guests (see figure 2). The data collected for this phase will be the starting point for this study to identify the key pain points and opportunities to create an engaging and multifunctional product.

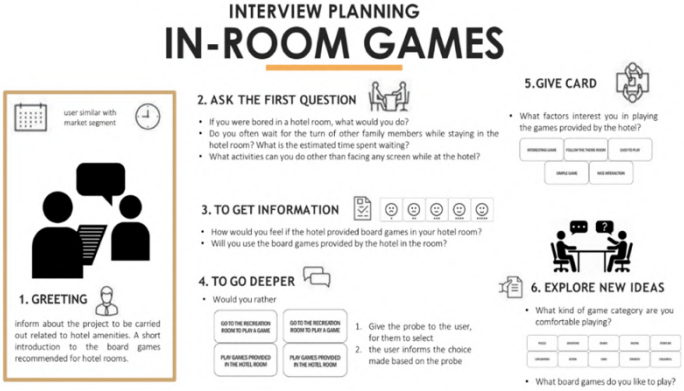

Figure 2. The interview planning with the hotel's guests.

Figure 3. The probing tools and questions with the hotel's guests.

During the interview, the researcher also used probing tools (Robinson, 2023) in parallel with user observation to get a spontaneous response during the session. The probing tools involved "emotion card", "would you rather a card" , and "sorting card", as shown in Figure 3.

Stage 2 Define: Problem Statement & Establish Design Criteria

This stage focused on synthesising the insights gathered during the first stage of empathy with the user. The researchers gathered all the insights based on the key point of "What are the hotel amenities that enhance guest experiences ?" The researcher highlighted the key themes, and user needs to form the basic design criteria for the design proposal (see Figure 4).

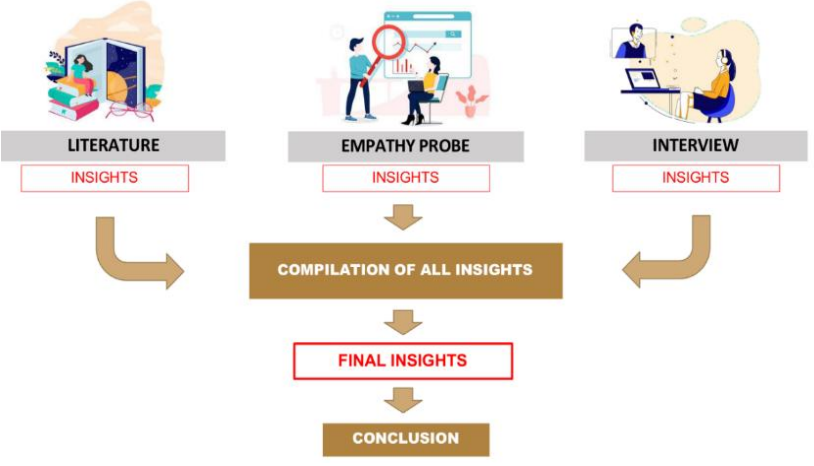

Figure 4. The process of define needs and problems.

Stage 3 Ideate: Generating Creative Solutions

In the ideation phase, multiple idea solutions and concepts were created and were brainstormed with diverse stakeholders to generate creative solutions. Multiple ideation techniques were used during this session, such as quick sketching, mind mapping and rapid prototyping, to explore various concepts that have interactive features that combine multifunctional tasks. (Isa, et al., 2022; Ali, et al., 2024; Yusof, et al. 2022)

Stage 4 Prototype: Building and Refining

This prototyping stage involved the researcher developing multiple low-fidelity prototypes of products with the features from the final data. These prototypes were created using various materials to test the features, size, and functionality. These low-fidelity prototypes were iteratively refined based on feedback from potential users and experts to ensure that the final product met the defined criteria from the data. (Isa, & Liem, 2014; Ali, et al., 2023; Yusof, et al. 2022)

Stage 5 Test: Real-World Feedback & Iteration

This final stage involved usability testing of the final design in a selected hotel room to gather real-world feedback. User testing was conducted with the hotel guests to evaluate the product's usability, overall impact on the guests' experiences, and engagement level. Qualitative feedback was gathered through interviews and observation, and then the results were analysed to identify areas for improvement for the final design. (Ali, et al., 2023)

RESULT & FINDINGS

This section will discuss the results and findings from the application of Design Thinking in the development of the UNWIND product. The outcome generated several valuable insights that align with the objectives of creating an interactive and engaging multifunctional hotel amenity.

Empathise: Understanding User Needs

	PERSONA 1	PERSONA 2	PERSONA 3	PERSONA 4	PERSONA 5	PERSONA 6
						
NAME	Faizal Ruhaijat	Faqhrul Syafiq	Iqbal Aqil	Yuyu Delilah	Eida Zahidah	Alisa Jamaluddin
AGE / GENDER STATUS	24 years old , Male Single	30 years old , Male Married	28 years old , Male Married	28 years old , Female Married	29 years old , Female Married	28 years old , Female Married
PROFESSION	Entrepreneur Risk-taker• Visionary	Maritim humble• Visionary• active people •responsible	Malaysian Army Risk-taker• hardworking• be careful • voluntary	Teacher Visionary• Opportunistic Attentive to environment	Teacher Opportunistic Attentive to environment	Teacher Risk-taker• Visionary• Opportunistic Attentive to environment
SALARY	RM2000-3000	RM3000-4000	RM4000-5000	RM4700-5500	RM5000-6000	RM5000-5500
BEHAVIOR	Expensive • personal stuff• Elegant and minimalist furniture	Use what they have• expensive sport equipment • Honda BRV	Ford Ranger • Expensive sport equipment • Fetish	Simple and study • personal stuff • lovely caring	Systematic person • Elegant and minimalist furniture	Humble • Punctual • minimalist
HOUSE / FAMILY MEMBERS	Flat Born in Kuala Lumpur Single mother and 3 siblings	Flat Born in Perak Husband and wife 1 boy	Terrace Born in Perak Husband and wife	Terrace Born in Melaka Husband and wife 1 girl	Terrace Born in Kelantan Husband and wife 1 boy	Terrace Born in Kedah Husband and wife 1 boy
EXPERIENCE / GOAL	-Focus on doing his work in the room at night -Ensure the equipment in the room is complete	-with the whole family to play and relax together in the room -keep everything in a comfortable condition	-less sitting in the room and always doing activities outside -do not want to be disturbed by outsiders and ensure full privacy	-English teacher -managing a large community	-Obsessing on Art -economical and management skills	-Painters -Art teacher -Classical Collectors

Figure 5. Demographic data of the six respondents.

Through the interviews, observation, and probing discussions, several key insights were gathered on guest preferences for in-room amenities. The demographic data for each respondent is shown in Figure 5. The data includes age, gender, income level, and education, providing a comprehensive understanding of the guests' preferences in relation to these demographics. From the questions that related to their experiences in the hotel's room with the family, this study has finalised 6 final key insights which illustrated in Table 1. From the table, it can be concluded that most guests opted for an enjoyment option to enhance their interaction and relationships with their family, partner, or colleagues. Furthermore, most guests would prefer products that provide cultural or educational values.

Table 1. Final key insights for the hotel's experiences

Final Key Themes	Insights
Need for relaxation, entertainment and stress relief	• The need for something that can help them unwind after a day of travel • They would have something to enjoy without leaving the room • Need some activities that balance relaxation, interaction, and engagement.
Interest in culture and educational value	• A strong interest in local culture added to the educational learning experiences. • Preference of hotel amenities that allow them to learn something new, experiencing elements of local culture from the hotel room
Wants something unique and interactive	• Guests expressed strong interest in something that engages them intellectually and physically and that can be shared with others. • Demand for interactive amenities over traditional static amenities.
Preferred Social and Family Friendly Activities	• Most of the guests travelling with family or friends appreciate amenities that encourage social interaction. • Prefer activities that foster connection and enjoyment with family or friends.

Considerations of Aesthetics appeal	• Guests valued the visual appeal of the product placed in the hotel's room • They prefer decoration items to serve as practical functions and also as a visual appeal for the hotel room
Inclusivity in Design	• Various ages gender and nationalities can use the product • Product that can be accessible and enjoyable for all types of demographics

Figure 6. shows the result of the probing question related to the game features, which reveals the guests' preference for the games they would like to have in the hotel room. The data indicates that the respondents prefer games that are easy to play and create activities that enhance their family bonding and could bridge the generational gaps.

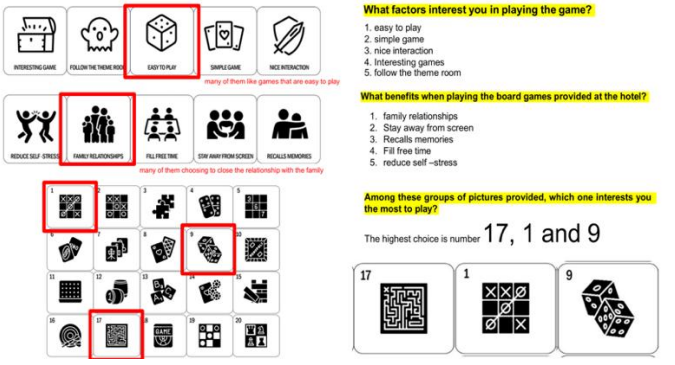

Figure 6. Games preferences based on the probing interviews.

Define: Problem Statement & Establish Design Criteria

During this phase, the researcher gathered all the user feedback into a clear problem statement (Figure 7) to identify the best in-room hotel amenities that are multifunctional and combine interactive play while enhancing guest experiences. At this stage, several key insights were developed under Point of View (POV) analysis and led to the establishment of design criteria focused on creating a product that is easy to use, educational learning, visually appealing and culturally enriching product.

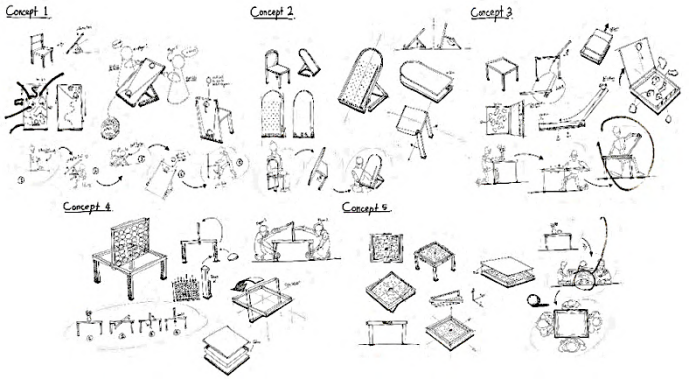

Figure 7. Summarize Point of View (POV) in linear unpacking.

POINT OF VIEW
Summarize of linear unpacking

We Met	We Noticed	We Are Amazed To Discover	It Would Be Game Changing
 Persona 1  Persona 2	• users really like games and competitions • users do not mind playing any game, willing to accept the challenge • users like games that take a long time to complete	• users are very experienced in organizing games • users worry if the game is small, not suitable to be played by children • users are afraid of accidents as well as possible damage to the games played by their children.	• provided various types of games for guests to choose and try for themselves the types of games provided. • provides a game that can be played even alone • the game provided is quite rugged and can be played repeatedly without getting bored.
 Persona 3  Persona 4	• users seem a little worried about the type of games available • users are interested in large -sized games, especially games that can be ridden by children	• the user tries to avoid games that emit loud noises rather than interfering with his or her mother's affairs • users want their child a challenging game because their child often plays outdoor games.	• if the toy is large size and easy to play with parental supervision in the room. • such games can increase the IQ of children, not just the pursuit of victory alone
 Persona 5  Persona 6	• users rarely play games especially board games. • users love on games that don't make clutter and noise • users love to try and explore new things	• users love games that can be played in full body even in the room. • users really like games that are large and unique to play because users like to stand while playing games	• if the game is large and it is clear how to play. • included historical elements as well as battles, augmented with specific themes. • the resulting game does not release any side music
	• users seem to be afraid of the topic of the game • users often bring games for their own children while traveling • the toys they bring are only for their child, not for themselves.	• users are afraid to give other toys to their children for fear that the preoccupation with the game will damage users do not like to share games for their children to the public, because they are worried about infection	• if the game can be ensured safety in terms of manufacturing • the game is not split into small fragments, nor into individual separate parts • the toy is not easily dirty and has no dangerous parts.

Figure 8. Multiple early ideations for concept selection.

Ideate: Generating Creative Solutions

The ideation process produced several concept proposals (Figure 8) for the interactive wall game, including multiple game formats and interaction methods. Concepts were generated using manual and digital sketches, inspired by data from stage 2. Then, the researcher created a collaborative brainstorming with some stakeholders to make a decision on the criteria and features for this new hotel amenities. Several product names were also developed during this session, and the

team decided to use UNWIND for the product, which represents *"…to relax and allow your mind to free…"*.

Prototype: Building and Refining

Multiple low-fidelity prototypes of UNWIND were made using various materials, such as paper, cardboard, foam and digital interfaces (see Figure 9). These prototypes were created to test the product's features and game elements. During the prototype testing, user feedback from the hotel guests and staff emphasised the importance of considering aesthetics and functionality. Most guests preferred a design that could integrate with the hotel room decoration while adding other purposes such as educational learning points, entertainment with fun and play elements, and the recommendation of something that can engage people inside room

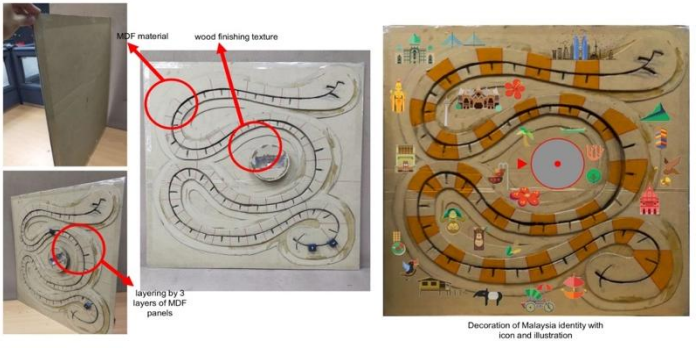

Figure 9. Low-fidelity prototypes that are iteratively built and refine.

Figure 10 illustrates a sample of how the researcher documented the respondent's feedback on the movement of the Player's Token, enhancement of the spinner, and rotation of the spinning mechanism. The rotation and spinning mechanism used in the design proposal was designed to create excitement, and the movement of the player's token across the gameboard is central to gameplay. During the testing, the respondents highlighted several problems and issues, and the feedback was recorded; several amendments were made to the prototypes and iteratively tested until the system and mechanism got

positive feedback from all the respondents. The iterative phases help the researcher to modify the design according to the recommendations given by the respondents and refine the major issues of the concept proposal. The iterative session involved in improving the mechanism and system of the game which the feedback from respondents were;

"…the players token are hard to move, it stuck on the track, maybe the track for token to move could be bigger and magnetic components at the token or attached a small hooks that allowing the token to move smoothly on the track across the gameboard…"

"…spinning wheel is better option compare to dice because dice can be lost somewhere in the room, while spinning wheel is attached at the game, we do not need something separate features from the game, people will lost it and the hotel need to find the replacement for the lost features.."

Figure 10. Sample of the evaluation results for the mechanism and system of UNWIND.

The researcher gathered all the positive and negative feedback and brainstormed the final solution for UNWIND as illustrated in Figure 11. This process contributes positively to improving the durability of the system and mechanism refining the gameplay experiences more unique and challenging to the user the UNWIND interactive and engaging nature, improving

the durability of the system and mechanism, refining the gameplay experiences more unique and challenging to the user. UNWIND has been modified by the researchers modifying the layout of the games to ensure that all features of the board create a smooth movement within all players creating more ability to the players when it comes to their turn.

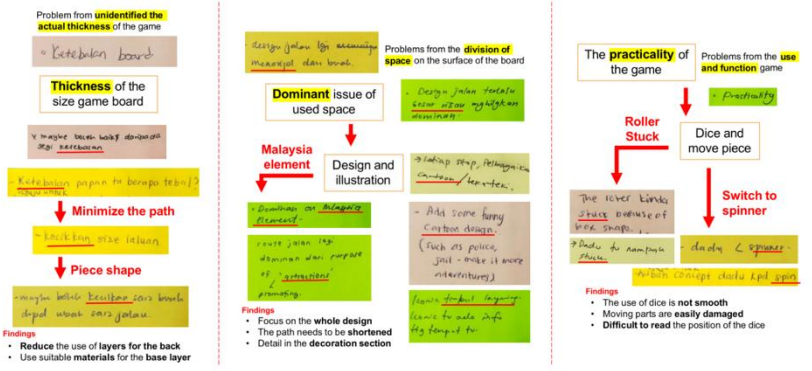

Figure 11. Feedback and refinement of UNWIND.

Stage 5 Test result: Real-World Feedback & Iteration

During this stage, the final product of UNWIND was tested in the mock setting of hotel room with previous hotel guests, which provided real-world feedback on the product's aesthetic value, engagement and usability (Figure 12). The data reveals that most the guests gave feedback that the game enhanced their overall experience. They mentioned that UNWIND was both entertaining and aesthetically pleasing and enhanced their knowledge of the iconic places in Malaysia. The majority of the guests argue that the game's multifunctionality is both a decorative art piece and also an interactive game for the people to engage. They mentioned,

"... this is a beautiful and unique piece of art that I will definitely buy and hang on my house wall to remember my memorable experiences in Malaysia. The iconic buildings and places on the board are nice, and we get to know the beautiful landmarks in Malaysia..."

"...I've been to so many hotels, but there was only an artwork on the wall, and frankly, it is beautiful but static looks only, no interaction. This product will make us play and create excitement to complete the games with our team members..."

"... I will play this with my family, especially my kids. This wall-decorated game is nice and easy to play, and it is nice if we can have a smaller version of this product..."

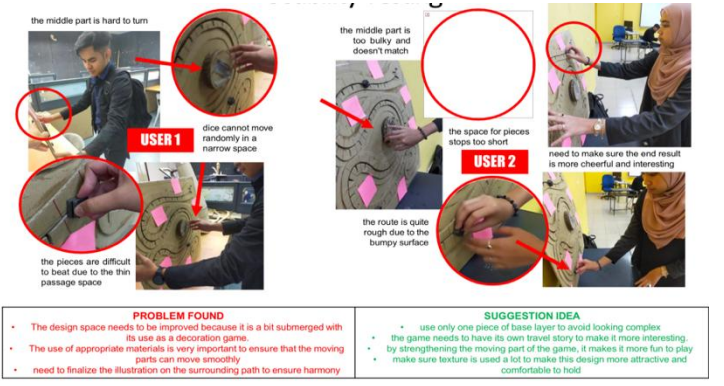

Figure 12. Usability testing on final concept of UNWIND.

The testing phase during this stage creates an opportunity for this study to gather real feedback from direct stakeholders to refine this product iteratively, enhance the tactile quality of the game features and simplify specific mechanisms and adjustable components to make this game accessible to a broader type of audience and market.

Figure 13. Final design of UNWIND product.

Final product of UNWIND is demonstrated in Figure 13. This figure showcases the culmination of the UNWIND process, highlighting the end result of this project. The results demonstrated that Design Thinking is a practical approach to developing user-centred hotel amenities. The results recommended that multifunctional and interactive amenities like UNWIND can increase guest satisfaction and represent a novel approach to redefining hotel amenities. By employing this design thinking approach, UNWIND functions as an engaging game and serves as a contemporary art piece promoting Malaysian iconic landmarks.

DISCUSSION

The results and findings from this research show that Design Thinking significantly impacts the development of innovative and user-centred hotel amenities. This section will elaborate on the critical insights gained from each process stage and emphasise the broader implications for the hospitality industry. The application of the Design Thinking process in the development of UNWIND impacts the final product outcome of hotel amenities that enhance guests' experiences, which combine arts, education, play and aesthetic values. This product was successfully designed with the application of “Empathize”, “Define”, “Ideate”, “Prototype”, and “Test” in the process.

CONCLUSION

The product outcomes from this Design Thinking approach generate valuable insight into how hotels can innovate their offering to their guests. The approach makes UNWIND a culturally engaging product, balancing functionality and aesthetics that can also enhance the hotel guests' experiences. Using Design Thinking in the development process of UNWIND benefits designers, stakeholders and hotel management, enabling them to explore this method and implement it in other hotels' product development, project management, systems or services which focus on guests-centred solutions parallel with the claims that make by Auernhammer. (2021)

The hotels can develop multiple types of hotel amenities that enhance their brand loyalty and create a competitive product by placing their guests in the middle of their design process. This methodology demonstrates its potential to drive future innovation in the hotels industry. The researcher or the designers that implement this approach in their design development need to carefully consider the tools used during the process in order to get an effective design solution.

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HUMAN-CENTERED DESIGN IN PROMOTING LANGKAWI'S CULTURAL HERITAGE: MAHSURI DOLL HOUSE INNOVATION

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Abstract

This paper explores the development of the Mahsuri Doll House, a miniature replica inspired by the legendary Rumah Mahsuri, using a Human-Centered Design (HCD) approach. By integrating myths and legends into product design, the project aims to preserve and promote Langkawi's cultural legacy through an educational medium. The innovation process involved deep user engagement to ensure the product resonates with diverse audiences, including students, educators, and tourists. Through this approach, the Mahsuri Doll House serves as a creative tool to make Langkawi's folklore accessible, engaging, and educational , while fostering cultural appreciation. The paper not only highlights the successful application of the HCD approach but also underscores the potential of merging traditional narratives with modern design techniques. This potential offers a hopeful and inspiring outlook for the future of cultural preservation and product design.

Key words: Human-Centered Design, Cultural Heritage Product, product innovation

INTRODUCTION

The legends and folklore of culture play an essential role in preserving its identity, offering new windows into its history, beliefs, values and human experiences. (See, 2024; Anuar, et al., 2021)

Langkawi is one of the Malaysian Islands that are rich in myths and legends. It has 99 islands, each of which has its own stories. The legend of Mahsuri, a woman who has been wrongly

(a) (b)

Figur 1 (a) Overview map of Langkawi consist of 99 Island and (b) The illustration of Mahsuri.
Source : Tourism Malaysia, Mininstry of Tourism.

accused of adultery and cursed for seven generations, has been passed down through generations and is deeply embedded in the identity of Langkawi (figure 1). The legends of Mahsuri stand as a cornerstone of the island's cultural heritage and are the famous icon and symbol of the island. (Anuar, et al., 2021; Razak, & Ibrahim, 2017) However, as modernisation accelerates and traditional forms of storytelling evolve, there is a growing need for innovative ways to preserve and communicate these cultural narratives to younger generations and global audiences. (Saxby, 2018; Anuar, et al., 2021) The Mahsuri Doll House, a miniature replica of Rumah Mahsuri, represents this study to merge modern product design with the rich cultural legacy of Langkawi to offer an interactive and educational experience. This study project will draw on the principles of Human-Centered Design (HCD) to ensure the product outcome is not only engaging and accessible to a wide audience but also culturally meaningful to the people. By focusing on user needs, particularly in educational contexts, the Mahsuri Doll House aims to bridge the gap between traditional storytelling and contemporary learning tools, fostering a deeper understanding

of Langkawi history. This paper outlines the development process of Mahsuri Doll House through the lens of HCD, highlighting how cultural heritage can be preserved and promoted through design that enhances people's experiences and create a new meaning for people. This study will explore how myths and legends can inspire innovative products for educational and cultural purposes. Through this case study, this study demonstrates how HCD approaches can contribute to sustaining cultural legacy in this rapidly changing world in which our young generation is more focused on digital things. (Silva, 2020)

This study explores how HCD design principles can be applied to developing culturally inspired educational products, using the Mahsuri Doll House as a case study. The project seeks to demonstrate how traditional narratives, such as measuring Legends, can be preserved and made accessible through user-focused and innovative design. The objectives of this study are:

1. to develop a promotional and educational product that transforms Langkawi's folklore into interactive learning tools that foster a more profound understanding and appreciation of local heritage.
2. to explore HCD principles in developing myths and legend as inspiration for product innovation and engagement.

HUMAN-CENTRED DESIGN METHOD

The HCD approaches include techniques and methods designers use to develop and create products, systems, or services with a deep understanding of human needs, wants and behaviour. According to Isa & Liem, (2015); Ali et al., (2023) and Marchese, (2021) the core principle of HCD is to place users and stakeholders as a primary focus in the design development process to ensure that the outcome of the product will fulfil user needs and effectively solve design problems. (Boy, 2017; Burns, 2018; Isa, & Liem, 2023) In this study, HCD will be explored on how this approach can be incorporated with culture into design development in developing a product that is inspired from myth and legends. The combination of creativity, culture and HCD

approach will enhance designers' discoveries in understanding human needs that can drive positive change in innovations and inspire new perspectives in designing new product development. (Isa & Liem, 2015; Ali et al., 2023)

RESEARCH METHODS

This study employs a qualitative HCD approach (Lopez, & Bhutto, 2023; Isa & Liem, 2015; Ali et al., 2023; Silva, 2020), focusing on the development and evaluation of Mahsuri Doll House as an interactive educational tool. Researchers from Universiti Teknologi MARA, Universiti Putra Malaysia, and Multimedia University conducted this study in collaboration with the Langkawi Development Authority (LADA). This study was structured in three phases: (i) Phase 1: User research; (ii) Phase 2: Design Development; (iii) Phase 3: Product evaluation (see figure 2) that aligned with HCD principles to ensure that the product will address the isues and challenges, preferences, needs and experiences of the intended users. (Silva, 2020)

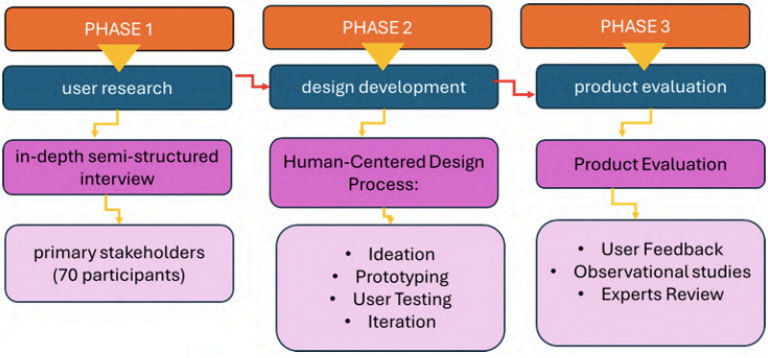


Figure 2. Three key phases of research development.

Phase 1: Study on User Research

This phase allows the researcher to gather insights into the target audience's needs, cultural understanding, and expectations of an educational product based on the folktale of Mahsuri legend in Langkawi. This study involved a total of 95 participants, including local and international tourists, students,

and local residents who were randomly selected at the tourist spot area. Meanwhile, the cultural, tourism and designer experts were selected based on suggestions from the main collaborator, LADA. An overview of the respondents' background is illustrated in Table 1. In order to ensure the systematic and clarity of data organisation, initial codes for all participants were created and recorded in Table 1. All participants were primary stakeholders of this study to gain an overview of their diverse perspectives on educational and cultural experiences. This study conducted in-depth interviews methods adapted from Schober (2018); Isa, & Liem, (2021) and Baxter, & Jack, (2008), to understand the following context:

Table 1. Overviews of Respondents' Background

Respondents	Participants Coding	Age	Male / Female	Type of employment	Education
International Tourist (IT) (20 pax)	IT1 – IT15	22 - 65	8 males 12 females	Engineers, Teachers, Accountants, Content Creators, Consultant, Business, Professor	Degree, Master, PhD
Local Tourist (LT) (20 pax)	LT1- LT15	18 – 54	10 females 10 males	Executive, Teachers, Lecturers, Business, Bank Officer, Manager, Software Developer	Diploma, Degree , Master, PhD
Local Residents (LR) (20pax)	LR1- LR20	19-67	11 males 9 females	Students, Business, Operator, Executive, Chef, Doctor, Nurse	Diploma, Degree, Master
Experts:					
LADA Authorities (LA) (6pax)	LA1-LA5	32 – 55	3 males 2 females	LADA Director Executive Officers Senior Rangers	Degree, Master, PhD
Tourism Authorities (TA) (2pax)	TA1 – TA2	44-45	2 females	Deputy Director Executive Officers	Master, PhD
Cultural Authorities (CA) (2pax)	CA1 – CA2	44-45	2 females	Director Executive Officers	Master, PhD
Designers (D) (15pax)	D1 – D15	25 – 31	7 males 8 females	Product Designers UX / UI Designers Interior Designers	Diploma, Degree, Master
Educators (E) (10pax)	E1 – E10	28 – 55	8 females 2 males	Lecturers, Teachers, Trainers	Degree, master, PhD

Phase 2: Initial Ideas and Design Development Process

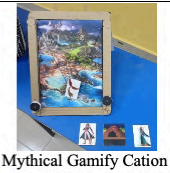
Phase 2 was the process of this study's translation of user insights into product design that will effectively communicate

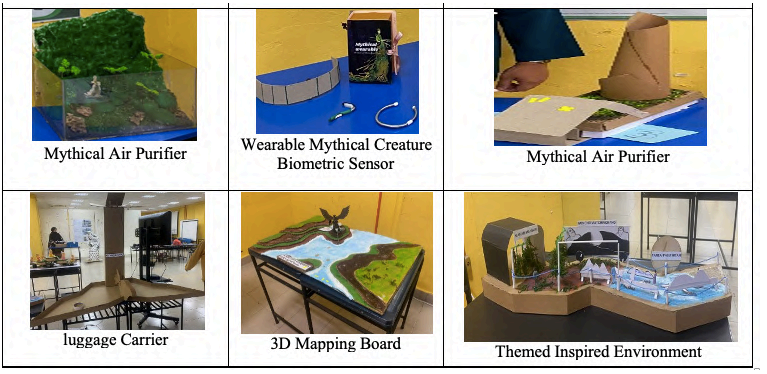
the Mahsuri legend into a new form of cultural engagement that also serves as an educational product for people to learn about Mahsuri and Malaysian Culture. HCD methods for idea development were used during this phase are:

1. Ideation

Based on the user research data, 15 initial ideas for the combination of Myth, Legends, and Mahsuri product proposals were brainstormed and critiqued (refer Table 2). After the critique process, the most promising ideas were shortlisted, and further refinement focused on combining the best elements from the multiple concepts. The product proposal selection was based on the cultural impact, novelty of the ideas, educational engagement, and aesthetic factors.

Table 2. 15 different initial ideas combining elements of Langkawi myths and Legends and the story of Mahsuri.

Initial Ideas with low-fidelity prototypes		
 Diorama Mahsuri House	 Mahsuri Monument	 Queen Of Langkasuka Doll
 Langkawi Legends Quest: An Interactive Mythical Board Game	 A Langkawi Mythical Quest Board Experience	 Mystical Realms: Portals of Langkawi Chronicles
 Design Myth Bag Packaging	 Mythical Gamify Cation Elements	 Mythical storytelling gift box



2. Prototyping

After the brainstorming and critiques session, several promising concepts were selected for further development. During this stage, low-fidelity prototypes were made to explore the design's practicality and also to test the engagement with the user, design elements, size and scale, interactive features, and visual representation (refer to Figure 3).

Figure 3. Multiple selected ideas for further development to test with the user.

3. User testing

The prototypes were tested with the sample of the target audiences to gather feedback on usability, engagement and educational value. Participants were asked to interact with the prototypes, explore their features, and they will share the

the prototypes, explore their features, and they will share their thoughts on design and overall user experience.

4. Iteration

Based on the feedback, the researcher modified the ideas to improve the concept ideas' functionality, cultural representation and user experience. The iterative nature of the prototyping phase allowed the team to continuously test and improve the product , ensuring the final design aligned with the project goals.

Phase 3: Product Evaluation and Refinement

After completing the design development process, this study focused on one final concept and developed it into one final prototype to assess the effectiveness of the final product in meeting the project's aims and objectives in education, cultural preservation, and user engagement. The final version of Mahsuri Doll House was used for observational studies conducted with multiple stakeholders in an educational setting to evaluate how the product is used in practice and its impact on interactive learning. The collaborative interview was held during the session with experts to ensure the accuracy and authority of the cultural element represented in the final design and how well the product conveys the Mahsuri legend, which will engage people in learning about Langakwi's cultural heritage.

Data analysis

The qualitative data from the interview and observation were analysed using thematic analysis, and methods of analysis were adapted from Schober (2018); Isa, & Liem, (2021) and Baxter, & Jack, (2008), to identify themes and user preferences. The results from the data are used to develop a product that meets the study objectives, which is to develop a promotional and educational product that transforms Langkawi's folklore into interactive learning tools that foster a more profound understanding and appreciation of local heritage.

RESULT

The results of this study demonstrate the positive application of HCD in developing an educational product inspired by myth and legend that promotes and preserves cultural heritages through the development of the Mahsuri Doll House project. Through each step of the HCD approach, this study will reveal several key findings:

User Research Findings

From the extensive data gathered during the phase 1 in-depth interviews with 95 users, this study finalised three main themes that emerged throughout the interview response.

Theme 1: Cultural Engagement

Most of the respondents, both local and international audiences, had limited knowledge of the Mahsuri legends; they were intensely interested in Langkawi's cultural stories. Most participants expressed enthusiasm for a product that could provide engaging ways to learn about the island's history, especially myths and legends.

Theme 2: Educational preferences

Most respondents emphasised the need for interactive learning tools that stimulate curiosity and provide hands-on experiences. They preferred visual and tactile elements, indicating that a physical model like the Mahsuri Doll House would be more effective than digital material.

Theme 3: Tourist Interest

The data suggest that tourists visiting Langkawi were interested in exploring local culture and history, particularly through immersive experiences. Most of the respondents say interactive products could enrich their travel experiences and deepen their understanding of the island's heritage. Table 3 provides a comprehensive summary, overview of user research findings from the user interviews. It provides a clear structure for easy references and understanding of the insights gathered from the research process. The table includes the final key

themes and notable quotes from selected respondents providing a valuable feedback to serve a fundamental meaning and decision making in the design development of the product.

Table 3. Overview of user research findings from the user interviews.

Category	Percentages	Findings	Sample Quotes
Awareness of Langkawi legends	International Tourist 10% have basic knowledge	Limited knowledge of Mahsuri Legend, some were familiar with the name but not	Respondents IT4---------- "...never heard of the legend. I came here for the scenery, and then I will depart from here to
	Local Tourist 35% had heard about Mahsuri Local Residents & Experts 100% fully aware	the whole story	Phuket..." Respondents IT19---------- "...I love culture and heritage, but I do not know about Mahsuri, I heard some name of it, but never knew if. The promotion that we have on Geopark UNESCO..." Respondents LT3---------- "...familiar with name only, Mahsuri... but only on the surface story, no idea of what is all about..."
Interest in myth and legends	International Tourist 90% have a strong interest. Local Tourist 75% have strong interest Local Residents & Experts 100% interest	Most of the respondents have a high interest in Langkawi folklore and cultural heritage ;they also stated that they would look forward to learning about these stories in engaging methods.	Respondents IT7---------- "...I would love to know more about Mahsuri story, I will google it after the interview, any place that promotes Mahsuri in Langkawi ? I would really love to go..." Respondents IT15---------- "...last time I remember , there was a place called Tomb of Mahsuri, but I have never been there because I heard from the locals there is nothing there...It's good if they promote this legend more ..."
			Respondents LT11---------- "...it is a bit sad because now the place to promote Mahsuri is totally out of order...it is so sad that younger generations are even not aware of these legends..."

Preferred Methods of Learning	Visual tools preferences 85% Interactive tools preferences 88% Traditional tools 20%	Most of the participants preferred interactive and visual tools, such as physical, tangible models, videos, and hands-on exhibitions, to traditional learning methods, such as lecture-based or traditional text learning methods.	Respondents D3---------- "…somethings that we can learn by touching and experimenting, it will be a good combination of technology and traditional things, such an interesting cultural product that teaches everyone with something unique…" Respondents TA1---------- "…we need something that can promote our culture to younger generations, nowadays younger generation does not bother about heritage folklore stories, how to attract them, how to make them interested? …" Respondents E5---------- "…visual that is engaging would be interesting, and don't forget we still need the brochure, and book to promote even it is old school but still it is still relevant method…"
Educational Product appeal	Positive feedback: 90% give positive feedback on the concept proposal	The proposed concept of Mahsuri Doll House as an education tool for preserving cultural heritage received a positive feedback	Respondent E7---------- "…I like all the proposal that have interaction that user can touch, feel and can create a storytelling while exploring the product…" Respondent LT---------- "…it is something people can explore together and can be used by 4-6 people; it is good and will enhance kids' imagination…" Respondent IT2---------- "…it is something that we can play with our kids, and can learn the culture element ..it is good…"
Cultural Significant	90% of the respondents agreed that cultural preservation is important.	Participants emphasised that preserving the Mahsuri legend is important for maintaining Langkawi's cultural identity, particularly in educational contexts.	Respondent IT17---------- "…I'm from Norway, we have rich stories of our own myth and legends and we also believe Malaysian should promote the legends in multiple way…Mahsuri is an icon of Langkawi so need to make sure every generation remember Mahsuri as a legends queen in Malaysia…" Respondent LR3---------- "…last time 20 years ago Mahsuri is so popular, but now the promotion of Mahsuri just vanish , and younger generation not really know who is Mahsuri, this legend need to be sustain and should include in educational system…"

Design Development Outcomes

The data collected during phase 2 of the design development process led to the identification of three main themes for this study:

Theme 1: Prototyping User testing

During this session, participants responded positively to the Mahsuri Doll House design concepts; the participants highlighted the improvement in the scale layout to enhance interaction.

Theme 2: Interactive Features

Based on the user's suggestion, more interactive elements, such as movable components (e.g., doors and windows) and informational pop-ups, were incorporated into the final design (see Figure 4a and 4b). This allowed for both playful engagement and educational value, meeting the needs of both young and adult users.

Figure 4a. Suggestion for interactive features for the final concept.

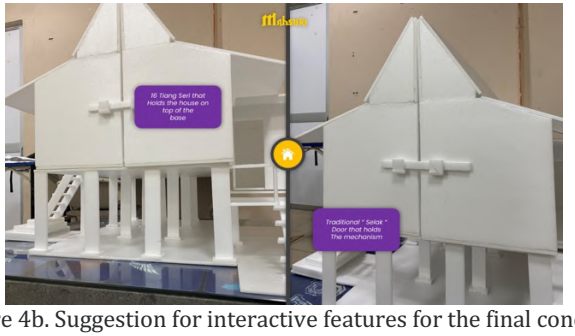


Figure 4b. Suggestion for interactive features for the final concept.

Theme 3: Cultural Authenticity

The experts' review validated that the final product captured the key elements of the Mahsuri legend and the architectural features of Rumah Mahsuri. This validates that the product can serve as a culturally authentic educational tool (see Figure 5)

Figure 5: Expert review of the 3 proposals proposed for the final concept.

Product Evaluation Results

The data gathered during phase 3 for the product evaluation result has finalised three main themes. Each of these themes will be further describes to gain deeper insights into the overall evaluation result:

Theme 1: Educational Impact

Observational studies in the educational environment showed that the final concept of Mahsuri Doll House effectively engaged participants in learning about Langkawi's cultural history. Most of the participants reported that the product sparked interest in Mahsuri legends and Malaysian unique culture, providing a tangible connection to actual Malaysian traditional houses in real-life situations. Educators' feedback that the product increased student engagement and the students stated that they felt more connected with the content. The Educator code E5 stated that;

> *"…the design of rumah Mahsuri made my student actively participate in the storytelling session…when we presented the legends, they asked a lot of questions and discussed with each other, I can see how they show their curiosity about Langkawi's Cultural history and they wanted to visit Rumah Mahsuri in Langkawi for the onsite experiences…"*

Theme 2: User engagements

During a collaborative discussion with the stakeholders, they revealed that Mahsuri Doll House is visually appealing and informative. The interactive design elements were particularly well-received as they encouraged deeper arguments with the cultural contents. The experts code LA1 mentioned;

> *"…most of us are quite satisfied with the final product outcomes. It is visually appealing even though it is only a prototype that is still under refinement, but we feel that this product can be developed further for refinements before it goes to the final production…"*

From the statement above, it can be concluded that this Mahsuri Doll House gathered positive feedback on user engagement. They found the product visually appealing and informative, which enhanced engagement and learning.

Theme 3: Cultural Preservation

Feedback from the cultural experts confirmed that the Mahsuri Doll House succeeded in promoting Langkawi's heritage while presenting it in a way that resonates with modern audiences. The product was seen as a valuable tool for preserving the Mahsuri legend and ensuring its continuity among future generations (see Figure 5). The experts TA1 confirmed that the Mahsuri Doll House represented the cultural architectural aspect of Rumah Mahsuri and the legend, he stated;

> *"…I had high satisfaction with the overall design; the design focuses on attention to detail and educational value. It is still missing some accuracy, which makes it impossible to make it exactly like the actual house due to time and financial constraints; this effort is highly satisfactory…"*

Some of the experts gave some recommendations for improvements, D3 recommended that;

> *"…it should combine with more interactive features; it will be good if each of the features includes some audio explaining the function and what the features are used for during the times…"*

Meanwhile, the other experts also gave their recommendations, D7 & LA2 suggested;

> *"... combination digital interaction inside this Mahsuri Doll House will be interesting, add on some LCD screen for some engagement with the users , maybe some digital screen to show the introduction of Mahsuri legends.."*

> *"...I think the product will create more meaning if some features such as audio narration or even more advanced with augmented reality of Mahsuri figures moving inside the house to do the house chores?...it is really like a real story for the user to explore the movement and it can further enhance the experience..."*

Figure 5. The final concept of the Mahsuri Doll House.

DISCUSSION

Most of the experts expressed high satisfaction with the final product and acknowledged the concepts' educational engagement and aesthetic appeal. Many mentioned the unique way it blended storytelling with modern design principles, making the product's cultural narrative context accessible to different demographics. However, while the feedback was positive, some experts suggested there is a need to add more attention to details in more layers of interactivity, such as audio narration or augmented reality features, to enhance the educational experiences further. When compared with another cultural preservation initiative in the market, the Mahsuri Doll

House stood out for its combination of educational focus, interactive and engagement elements with people and aesthetic appeal representing the actual traditional Malay house. This product offered a different approach to cultural and education engagement by making Langkawi's folklore tangible and relatable, which includes features not commonly found in other preservation efforts that often rely on static display or written narrative.

CONCLUSION

The Mahsuri Doll House represents how traditional myths and legends can be translated into modern unique educational products using an HCD approach. The product effectively engages diverse audiences, enhances cultural understanding, and contributes to the preservation of Langkawi's heritage, making it a valuable asset in both educational and tourism contexts. The HCD approach proved effective in aligning the product with the needs and preferences of its target users. The initiative proof of prototyping and user feedback allowed for the continuous refinement of the product, ensuring it was both user-friendly and culturally authentic.

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PRINCIPLES OF EMPATHETIC COMMUNICATION DESIGN FOR SUSTAINABLE PRODUCT DESIGN

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Abstract

Empathetic design principles in visual communication design emphasize a deep understanding of users' needs, wants, and experiences to create more meaningful and effective solutions. In the context of sustainable products, empathetic design can be a powerful tool to encourage more conscious and responsible consumption patterns. This study aims to explore how visual elements such as interfaces, information, and branding can be designed with the user's perspective and experience in mind. By using an empathetic design approach, designers can create visual communications that are not only aesthetically appealing, but also educate and inspire users to switch to more sustainable products. This study will provide insights into strategies and methods that can be used to integrate empathetic principles into the design process, as well as their impact on the adoption and use of sustainable products. Through this approach, it is hoped that visual communication design can play an important role in facilitating the transition to more conscious and responsible consumption patterns, supporting environmental and social sustainability.

Key words: empathetic design, visual communication, sustainable products

INTRODUCTION

The principles of empathetic design focus on a deep understanding of the needs, desires, and experiences of users. In this approach, designers not only consider functional and aesthetic aspects, but also understand and respond to the emotions and perspectives of users. Empathetic design involves

a process of in-depth research, observation, and direct interaction with users to identify and address real problems that users face. Thus, empathetic design aims to create products and services that not only satisfy functional needs but also provide meaningful and emotional experiences for users.

Visual communication design supported by the principles of empathy plays an important role in conveying messages and information in an effective and engaging way. By understanding the perspectives and needs of users, designers can create visual elements that are not only aesthetically appealing but also relevant and easily understood by the audience. Empathy allows designers to see the world from the user's perspective, so that users can create visual communication that is more intuitive, inclusive, and effective in conveying messages. In this context, empathy is the key to bridging communication between products or services and users. Empathetic visual communication design has great potential to drive sustainable products. By creating visuals that educate and inspire users about the benefits and importance of sustainable products, designers can influence more conscious and responsible consumption patterns. Design that focuses on the user experience can help overcome the psychological and cognitive barriers that often hinder the adoption of sustainable products. Through strong and relevant visual narratives, designers can encourage behavioural change and build awareness about the importance of sustainability in everyday life.

So far, product designers in Indonesia have often been more involved in product design principles such as ergonomics, sustainable materials, and innovative manufacturing techniques and technologies. However, the aspect of empathetic visual communication design is often less considered. In fact, strong visual communication can strengthen the sustainability message and make the product more attractive to users. Lack of attention to empathetic visual communication design can result in a lack of understanding and appreciation of the sustainability values carried by the product, thus inhibiting the adoption and use of the product. This study attempts to provide a case study that carries out the collaboration between product design and

visual communication design, by involving certain trends and works of designers as well as the meaning of the message that is currently being discussed. By combining the principles of empathetic design in visual communication, it is hoped that a solution can be created that can break the sales saturation point and encourage the adoption of sustainable products. This research will explore various strategies and approaches that can be used to create effective and empathetic visual communication, so as to increase user awareness and interest in sustainable products. Through synergistic collaboration between product design and visual communication design, it is hoped that products can be created that are not only innovative and sustainable, but also have strong and relevant visual appeal.

RESEARCH METHODS

The research method is carried out with a descriptive qualitative approach, namely by prioritizing the application of empathetic design principles that can be applied in visual communication design to support sustainable products. These principles include a human-centred approach, local cultural prototyping, and a business perspective, each implemented in three main applications: inclusive design, immersive visual communication, and sustainable product design. The following is a table of methods that combine empathetic design principles with the application of visual communication design:

Table 1 - Principles of Empathetic Communication Design for Sustainable Product Design

Empathetic Design Principles	Inclusive Design	Immersive Visual Communication	Product Design Sustainability
Human Centred	Create designs that are accessible to different user groups with different needs.	Using engaging and interactive visuals to increase user engagement.	Creating visual communications that educate users about the importance of sustainable products.
Local Culture Prototyping	Integrating local cultural elements into design to increase relevance and acceptance by local users.	Creating visuals that reflect local cultural identity and provide an authentic experience.	Using sustainable local materials and techniques in product design to support the local economy.
Business Perspective	Developing designs that are not only inclusive but also commercially profitable.	Implementing effective visual strategies to increase brand engagement and customer loyalty.	Promoting sustainability values as part of business strategy through visual communication.

Human Centred in the table illustrates the application of empathetic design principles that focus on the needs and experiences of users in the context of visual communication design. In this case, inclusive design means creating visual solutions that are accessible and relevant to a variety of user groups, including users with special needs, so that each individual feels included and cared for. (van der Bijl-Brouwer & Dorst, 2017) Immersive visual communication refers to the use of engaging and interactive visual elements to increase user engagement, allowing users to experience and understand the message more deeply. Finally, in the context of sustainability product design, a human-centred approach is used to educate and inspire users about the importance of sustainability through effective visual communication, thereby encouraging the adoption of more responsible and environmentally conscious consumption patterns. Local Culture Prototyping in the same table highlights the importance of integrating local cultural elements in visual communication design as part of the empathetic design principle. (Zhang, 2009)

In inclusive design, this means creating visuals that are relevant and easily accepted by the local community, taking into account the cultural values and symbols that users recognize and value. In the immersive aspect of visual communication, visualizations that reflect local cultural identity can provide a more authentic and engaging experience, allowing users to feel more connected to the product or message being conveyed. (Bazzano et al., 2017) Meanwhile, in the context of product design sustainability, involving local culture also means using local sustainable materials and techniques, which not only support the environment but also strengthen the local economy. Thus, design based on local cultural prototyping is able to create products and visual communications that are more relevant, accepted, and sustainable.

Business Perspective also in the table above explains how the principle of empathetic design is applied from a business perspective in visual communication design. (Zott & Amit, 2010) In the context of inclusive design, this approach means developing designs that are not only socially inclusive but also provide commercial value, by ensuring that the design can

appeal to a wider market and increase product accessibility. (Sihwinarti et al., 2024)

In immersive visual communication, the business perspective encourages the use of effective visual strategies to increase brand engagement and customer loyalty, which ultimately supports overall business goals. In terms of product design sustainability, this perspective focuses on promoting sustainability values as an integral part of business strategy, through visual communications that are attractive and educate consumers about the benefits and importance of sustainability, thereby enhancing brand image and attracting environmentally conscious consumers. (Darmawan et al., 2024) This approach ensures that the design not only functions socially but also has a positive impact on the business in the long term.

DISCUSSION AND DISCUSSION RESULTS

In an effort to create more relevant, memorable, and responsible products and services, three main approaches in visual communication design; Inclusive Design, Immersive Visual Communication, and Sustainable Product Design; play a crucial role. (Ahmad, 2018) Inclusive Design ensures accessibility and connectedness for all users, Immersive Visual Communication creates an immersive and interactive experience, while Sustainable Product Design promotes sustainability values. (Skerlos, 2015) Together, these three approaches enable designs that are not only aesthetically pleasing, but also have a positive social and environmental impact, supporting the transition towards more conscious and responsible consumption patterns.

1. Inclusive Design

Inclusive Design refers to the application of empathetic design principles to create visual communications that are accessible and relevant to various user groups, including users with special needs. (Steinfeld & Maisel, 2012) Inclusive design aims to ensure that every individual, regardless of background, physical ability, or special needs, can understand and interact with the products or services presented. (Clarkson et al., 2013) This involves a deep understanding of diverse audiences and integrating features

that allow for greater accessibility, such as the use of contrasting colours, easy-to-read typography, and intuitive visual elements. For example, in the context of a website promoting sustainable products, inclusive design can be implemented by ensuring that the site is accessible to users with visual impairments through the use of alternative text on images, keyboard-accessible navigation, and support for screen readers. Additionally, the design can include content in multiple languages or the inclusion of visual elements that reflect cultural diversity, so that users from different backgrounds can relate to the message.

A prominent case in point is Nike's "FlyEase" campaign promoting a shoe specifically designed for individuals with disabilities. In this campaign, inclusive design was applied not only to the product itself, but also to its visual communication. (Fleming, 2021) Advertisements and promotional materials featured individuals with different needs, used inclusive visual language, and ensured that information about the product's specific features was accessible to everyone. By doing this, Nike not only demonstrated a commitment to inclusivity, but also managed to expand its user market by appealing to a more diverse audience, including users who may not have previously felt the product was relevant to them.

Figure 1. Inclusive Nike FlyEase Campaign.
Source: nike.com/id/flyease.

Inclusive design, therefore, is not just about meeting accessibility standards, but also about creating meaningful experiences that respect the diversity of users. In the context of sustainable products, this approach is especially important because it allows products and sustainability messages to reach and influence more people, including users who may have limited access to information. (Kouprie & Visser, 2009) As such, visually inclusive design plays a role in reinforcing sustainability messages and ensuring that these values are widely accepted across the spectrum of users.

2. Immersive Visual Communication

Immersive Visual Communication refers to the application of empathetic design principles in creating visual experiences that emphasize the role of the user, namely interactive value, which is able to engage users emotionally and intellectually (Slater & Sanchez-Vives, 2016). Immersive visual communication design aims to capture the attention of users in a deeper and more meaningful way, often through the use of dynamic, interactive and memorable visual elements (Van Dam et al., 2002). This approach allows users to not only see, but also feel and participate in the message being conveyed, thereby creating a stronger connection between the user and the product or service.

For example, in a sustainable product promotion campaign, an immersive approach can be applied through the creation of interactive videos or virtual reality (VR) experiences that allow users to directly experience the impact of their consumption choices on the environment. (Perez-Marcos, 2018) For example, a company that produces sustainable clothing can use VR to take users on a visual journey of the process of making eco-friendly clothing, from material selection, production processes, to distribution with a low carbon footprint. (Dombrowski et al., 2019) Users can virtually “experience” how their decision to purchase the product contributes to environmental preservation, wich can ultimately encourage users to make more conscious and responsinle choices.

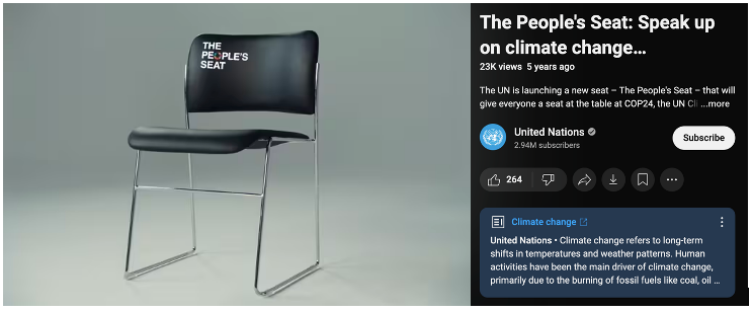

Figure 2. Immersive The People's Seat Campaign by the UN.
Source: news.un.org/en/story/2018/11/1026471.

One real-life example of the application of immersive visual communication is the UN's "The People's Seat" campaign at the COP24 Climate Change Conference. In this campaign, VR technology was used to bring participants and viewers into an environment affected by climate change, allowing users to see and feel the conditions faced by vulnerable communities. (Shepard, 2018) The use of immersive visual communication in this campaign successfully created a strong emotional impact, raising awareness and urgency among participants to take real action on climate changes for now and the future.

Immersive visual communication, therefore, not only attracts users' attention, but also creates a heartfelt experience that influences users' perceptions and actions. (Garcia et al., 2019) In the context of sustainable products, this approach is very effective in educating and motivating users to make better decisions, as users are directly confronted with the consequences of their consumption choices. By providing an immersive and memorable experience, immersive visual communication design can play an important role in reinforcing sustainability messages and inspiring positive behavioural in updated changes.

3. Sustainability Product Design

Sustainability Product Design highlights how empathetic design principles are applied to support sustainability through visual communication. This approach

focuses on creating visual designs that are not only aesthetically pleasing, but also educate and inspire users to understand and support environmentally friendly products. (Clark et al., 2009) Sustainability-oriented design seeks to convey a message about the importance of sustainability, educate consumers about the environmental impact of user choices, and promote more socially and environmentally responsible practices. For example, a brand that produces eco-friendly water bottles might use visual communication design that shows the life cycle of the user's product, from recycled raw materials, to the low-emission production process, to the final recycling of the product (Galati et al., 2022). This visual can be presented through clear and engaging infographics, or even through a video that details the lower carbon footprint of the user's product compared to conventional products. In this way, consumers are not only informed about the benefits of the product, but also given a deeper understanding of how the product contributes to environmental sustainability.

Figure 3. Sustainable Ice Bottle Packaging by Coca Cola.
Source: packagingoftheworld.com/2016/07/coca-cola-ice-bottle.

One example is the campaign carried out by Coca Cola by making bottles from ice cubes, an environmentally friendly idea that takes advantage of the synergy of serving soda in cold conditions . (Matthews, 1973) This idea uses ice as a packaging material that is integrated with the consumer

experience, especially in the context of cold drinks. In addition to reducing plastic usage, the concept also creates a strong and pleasing visual impact, increasing appeal and awareness of sustainability. (Ogilvy, 2016) It is an example of how innovative design can align environmental needs with user experience, while strengthening the brand image of a refreshing soda drink.

Another example is Adidas' "Run the Oceans" campaign, where shoes made from recycled ocean plastic were promoted using visual communication that emphasized the importance of keeping the oceans clean. (Green, 2022) The ads and user promotional materials used powerful images of polluted oceans, combined with a narrative about how every purchase of these shoes directly contributes to reducing ocean plastic waste. This well-designed visual communication is not only aesthetically pleasing but also conveys an important message about sustainability and inspires consumers to participate in the movement.

Figure 4. Sustainable Save the Oceans campaign by Adidas.
Source: adidas.co.id/en/runfortheoceans.

In the context of sustainable product design, visual communication design plays a key role in reinforcing and disseminating sustainability messages. By using educational and evocative visuals, companies can raise consumer awareness and motivate users to choose more environmentally friendly products. In addition, designs that consider sustainability can create a more positive and

responsible brand image, which in turn can increase customer loyalty and support sustainable business growth. Sustainability-focused visual communication design not only promotes products, but also invites consumers to play an active role in protecting the environment.

CONCLUSION

Empathic design principles, such as Human Centred, Local Culture Prototyping, and Business Perspective, offer a holistic approach to creating effective and relevant visual communication designs. With a focus on Human Centred, visual communication designs must be inclusive, ensuring accessibility for all users and considering the needs of various groups in their visual experiences. While Local Culture Prototyping allows the adaptation of designs according to local cultural values and symbols, making them more relevant and acceptable in certain communities. Business Perspective ensures that designs not only meet user needs but also support business goals by reaching a wider market and functioning effectively in a commercial context.

On the other hand, the application of inclusive, immersive, and sustainable visual communication design reflects a commitment to these empathetic design principles. Inclusive design focuses on accessibility and diversity, creating visual communication that is relevant to all users. Immersive visual communication involves a deep user experience, utilizing local cultural elements to strengthen the connection with the audience. While sustainable product design pays attention to environmental impacts by choosing environmentally friendly materials and efficient production processes. The combination of these approaches results in a design that is not only aesthetic but also functional and socially and environmentally responsible.

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THE USE OF EPOXY RESIN AS STAINED GLASS MATERIAL WITH CLASSIC AND MODERN TOUCHES

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Abstract

The Al Wustho Mangkunegaran Mosque's usage of stained glass is the subject of this study's field research findings. Stained glass is still produced today using antiquated techniques that are time-consuming and relatively expensive. This research suggests epoxy resin as a substitute material for stained glass. Epoxy resin was used because of its capacity to imitate stained glass, keeping a traditional appearance while providing the benefits of contemporary materials. Furthermore, the UV-resistant color pigments and epoxy resin utilized in this study have a great durability against exposure to sunshine and different environmental conditions. Compared to conventional stained glass techniques, the manufacturing process is simpler and more effective, which lowers production costs. In addition, the made-to-order manufacturing process enables product customization to satisfy customer expectations or particular decorative requirements. These results show that design solutions that are both culturally relevant and responsive to global demands can be produced by fusing traditional elements with cutting-edge technology. This method should shorten the lead time and lower the cost of producing stained glass while maintaining a comparable level of visual appeal.

Key words: Stained Glass, Epoxy Resin, contemporary innovation

INTRODUCTION

Stained glass has a long-standing history in both art and architecture, particularly within places of worships, where it plays a significant role in shaping architectural aesthetics and spiritual ambiance. In the context of Masjid Al Wustho

Mangkunegaran, stained glass serves not only as a decorative element but also as a natural lighting regulator, influencing the mosque's interior atmosphere. Observations reveal that the stained glass in the mosque produces two primary lighting effects: “colored" and “diffused.” The “diffused” effect softens illumination by scattering light and minimizing shadows, while the “colored” effect imparts subtle hues to incoming light, depending on the stained glass’s pigments. Ensuring the optimal function of these effects requires ongoing maintenance and attention to the stained glass's physical condition.

RESEARCH METHODS

The research method is carried out with a descriptive qualitative approach, namely by prioritizing the application of empathetic design principles that can be applied in visual communication design to support sustainable products. These principles include a human-centred approach, local cultural prototyping, and a business perspective, each implemented in three main applications: inclusive design, immersive visual communication, and sustainable product design. The following is a table of methods that combine empathetic design principles with the application of visual communication design:

Figure 1. Stained glass in Al Wustho Mangkunegaran Mosque
Source: Author, 2024

Traditionally, stained glass is produced by joining colored glass pieces with lead, and the hues are achieved through the inclusion of metallic elements—copper for green, cobalt for blue, and gold for red. Although these techniques

yield exquisite and unique works of art, they are time-consuming and demand a high level of craftsmanship. Furthermore, the findings at Masjid Al Wustho Mangkunegaran highlight the functional value of stained glass, including its ability to regulate heat and minimize excess light reflection. Despite these advantages, the reliance on traditional methods presents challenges, particularly in terms of production efficiency and the dependency on skilled artisans.

The influence of Gothic architecture on stained glass design is particularly relevant to this study. Gothic cathedrals are renowned for their use of stained glass to manipulate natural light, creating a mystical and awe-inspiring atmosphere. The stained glass in these structures not only allowed for colorful lighting but also diffused sunlight in ways that emphasized the spatial qualities of the interiors. (Santoso, 2014) Inspired by these precedents, the stained glass at Al Wustho Mosque similarly enhances interior illumination by filtering natural light to generate subtle, colored effects. However, maintaining this balance between aesthetic appeal and functional efficiency in modern times requires innovative solutions. To address these challenges, this study explores the use of epoxy resin as an alternative material to stained glass. Epoxy resin was chosen for its transparency and pliability, offering the potential to replicate the visual qualities of traditional stained glass with greater manufacturing efficiency. (Tauvana et al., 2020) This research aims to discover a creative solution that not only preserves the artistic appeal of stained glass but also simplifies the production and maintenance processes, aligning with contemporary demands for efficiency and innovation.

RESEARCH METHODS

This study employed an experimental methodology to assess the cause-and-effect relationships between the variables under investigation. (Em, 2024) Data collection involved field surveys and interviews with epoxy resin practitioners and other relevant stakeholders. Additionally, supplementary information was obtained from electronic

sources, including online databases, as well as printed materials such as reference books on epoxy resin and stained glass. In exploring epoxy resin as an alternative material to stained glass, the research also utilized a descriptive approach, focusing on the material's texture, color, and strength characteristics. In the early stages of the research, a literature study was conducted to understand the types and characteristics of resins, epoxy resin hardening agents, types of resin color pigments, and resin treatment methods. The results of this literature study are summarized as follows:

1. Types and Characteristics of Resins
   Epoxy resin is extensively used in mechanical, electrical, chemical, and civil engineering applications due to its high bond strength—reaching up to 2000 psi—and its resistance to wear, cracking, corrosion, moisture, and heat. Its transparent color and smooth texture make it a suitable alternative for replicating the aesthetic qualities of traditional stained glass. Polyurethane (PU) resin, recognized for its excellent abrasion resistance and durability, is commonly utilized across various industries. Similarly, melamine formaldehyde (MF) resin offers significant resistance to water and heat, making it ideal for electrical and mechanical components. (Utomo et al., 2021)

2. Epoxy Resin Hardener
   Epoxy resin hardeners are essential additives that accelerate the curing process, ensuring the resin solidifies effectively. Achieving the correct proportion of resin to hardener is crucial; an improper ratio can result in brittleness, compromising the strength and durability of the final product. (Ozeren Ozgul & Ozkul, 2018) The optimal mix not only ensures a strong bond but also maintains the resin's flexibility and visual clarity, which are essential for replicating the aesthetic qualities of traditional stained glass.

3. Color Pigments for Epoxy Resin
   Epoxy resin color pigments are essential for achieving the

desired visual effects, with different types offering unique characteristics. (Ozeren Ozgul & Ozkul, 2018) Liquid pigments provide transparent color with just a few drops, ensuring an even distribution throughout the resin. Metallic powder pigments add a shimmering luster due to their reflective particles, though they require thorough mixing to avoid inconsistencies. Powder pigments, by contrast, deliver bold and vibrant hues, making them ideal for more opaque designs. Paste pigments, known for their high concentration, are used to create intense, solid colors.

4. The Maintenance
   Maintaining epoxy resin involves several essential practices to preserve its appearance and durability. Regular cleaning with a soft cloth and mild soapy water helps remove dirt and debris, while re-polishing restores its original luster. (Rahman & Akhtarul Islam, 2022) Since epoxy resin can be vulnerable to UV exposure, applying UV-protective coatings is recommended to prevent discoloration and material degradation over time. This additional layer of protection ensures the resin maintains its aesthetic appeal and structural integrity, particularly in applications exposed to sunlight or other environmental factors.

5. Epoxy Resin Stained-Glass Manufacturing Process
   The manufacturing process of epoxy resin stained glass involves several essential steps, beginning with model and mold design. The design is created using specialized software, such as Adobe Illustrator, to serve as a precise guide for shaping the stained glass mold.

In the molding preparation stage, a 3 mm thick brass-copper sheet is cut using a laser machine and carefully smoothed to ensure accurate shaping and proper fit. The tools and materials used in this process include epoxy resin, hardener, color pigments, and various equipment such as stirring machines, copper molds, and plastic cups.

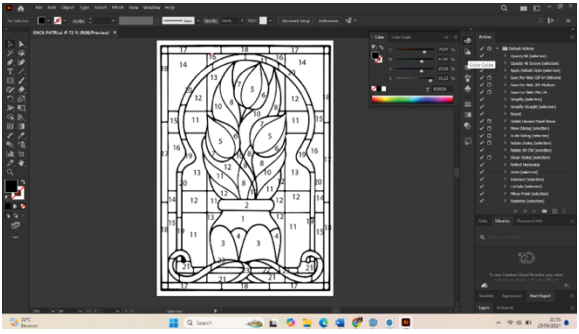

Figure 2. Design creation process with Adobe Illustrator software
Source: Author 2024.

Figure 3. Epoxy resin, hardener and liquid pigment
Source: https://www.epresin.art/

Figure 4.Stained glass and epoxy resin crafts
Source: https://www.pinterest.com

The manufacturing steps are as follows:

1. Mix the epoxy resin and hardener in a 2:1 ratio, ensuring thorough blending.
2. Divide the mixture into several containers, adding pigments to achieve the desired colors.

3. Pour the mixture into the prepared mold and allow it to dry for 8 to 12 hours.

Finally, the finishing step involves smoothing the surface with sandpaper, if necessary, to achieve a polished, glossy finish that mimics the appearance of traditional stained glass.

Visual Appearance and Light Distribution of Epoxy Resin

The visual effects and light distribution properties of epoxy resin, when used as an alternative to modern stained glass, stem from its unique optical and chemical characteristics. With its high refractive index, epoxy resin can refract light similarly to glass, creating comparable sparkle and dynamic color play. However, one of the primary challenges lies in achieving the right balance between color intensity and transparency. Careful selection and precise application of pigments are essential to attaining the desired optical qualities.

Traditional stained glass has the unique ability to disperse natural light evenly, while reducing excess heat and reflections. The use of color and texture in stained glass allows for soft light diffusion and even room lighting. This light distribution, especially if the stained glass windows are installed laterally, provides lighting with a natural yellowish effect and changes throughout the day according to the position of the sun. (Hartanti & Setiawan, 2014)

Although epoxy resin does not naturally offer the same level of light diffusion as stained glass, strategic pigment use and surface texture adjustments can mimic these qualities. Pigments control transparency and light transmission, while altering the surface texture can enhance the diffusion effect. As a result, epoxy resin demonstrates significant potential as a viable alternative material, particularly in applications that demand controlled light transmission and effective heat distribution similar to traditional stained glass.

Aesthetic and Functional Comparison between Stained Glass and Epoxy Resin

The findings of this study align with previous research, which identifies epoxy resin as an effective material for

replicating the appearance of stained glass. When combined with appropriate pigments, epoxy resin can produce color and lighting effects comparable to those of traditional stained glass. A key advantage of epoxy resin lies in its flexibility, both in application and color control, due to its high refractive index, which enables light refraction similar to that of glass.

However, the use of epoxy resin also presents challenges, particularly regarding its vulnerability to UV exposure, which can impact its color quality and transparency over time. While traditional stained glass demonstrates greater resistance to environmental factors, epoxy resin compensates with enhanced adaptability, offering comparable aesthetic results. This makes epoxy resin particularly advantageous for contemporary designs that require the visual appeal of stained glass but benefit from more flexible, cost-effective production methods.

RESULT

Figure 3. Epoxy resin stained glass results
Source: Author 2024

When applying epoxy resin on porous substrates such as concrete, wood, or plaster, it is essential to use a primer as a

base coat to enhance adhesion. The primer must fully cure before the resin is applied to prevent defects or imperfections in the final coating. Since porous materials tend to absorb the primer extensively, it is important to allow sufficient time for the initial coat to set effectively. The drying time of the primer varies based on ambient temperature: at 20°C, it requires 8-12 hours; at 30°C, 6-8 hours; and at 40°C, 4-6 hours. Adhering to these drying times ensures optimal performance and bonding, which is crucial for achieving a smooth and durable epoxy resin finish.

DISCUSSION

Excessive use of color pigments in epoxy resin can result in overly intense coloration, undermining efforts to achieve the desired transparency needed to replicate the qualities of traditional stained glass. Highly concentrated pigments hinder the translucent effect that defines stained glass, diminishing both the aesthetic appeal and functionality of epoxy resin as an alternative material. Therefore, careful adjustments in pigment usage are essential to strike the right balance between color vibrancy and transparency. Moreover, proper management of solvents during the epoxy application process is crucial to ensure safety and prevent health risks. Direct contact with the skin or eyes, as well as prolonged inhalation of vapors, must be avoided. The use of personal protective equipment (PPE), including gloves, goggles, and protective creams, is strongly recommended. Additionally, ensuring adequate ventilation—especially in confined spaces—is vital to minimize exposure risks during the application process.

The findings of this study indicate that, with precise pigment control and appropriate application techniques, epoxy resin can successfully mimic the optical effects of stained glass. However, achieving optimal results depends on several key factors, including careful regulation of coating thickness, color intensity, and transparency. While epoxy resin offers significant potential as an alternative to traditional stained glass, special attention must be given to the application process and material settings to ensure the desired aesthetic and functional outcomes.

CONCLUSION

This study demonstrates that epoxy resin offers considerable potential as an alternative material to traditional stained glass, particularly in modern applications requiring flexibility and cost-efficiency. When combined with appropriate pigments and applied using the right techniques, epoxy resin can replicate the aesthetic qualities and light effects of stained glass. However, achieving optimal results requires balancing color intensity with transparency, ensuring the resin maintains the desired visual and functional properties.

The study also highlights the importance of proper substrate preparation, emphasizing the role of primers in enhancing adhesion on porous surfaces. Adhering to recommended drying times is essential to prevent defects and ensure a smooth, durable finish. Furthermore, the use of personal protective equipment (PPE) and adequate ventilation during the application process is critical for maintaining safety and minimizing exposure to harmful solvents.

While epoxy resin offers advantages in flexibility, customization, and ease of application, it remains sensitive to environmental factors such as UV exposure. Therefore, additional protective coatings may be necessary to maintain its appearance and performance over time. Ultimately, epoxy resin presents a promising alternative for modern stained glass applications, provided that careful attention is given to its formulation, application, and maintenance.

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PAWUKON WUKU WUKIR ALMANAC AS A MOTIF FOR DIGITAL BATIK INDUSTRY PRODUCT DESIGN

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Abstract

Raden Wukir is a wise puppetry character and the first son of Prabu Watugunung. Wukir is the third wuku of the Pawukon calendar. Wuku Wukir is designed into a digital batik motif. Wukir is a mythical symbol of wisdom that carries Javanese local culture, but it has yet to be utilized in product design. The problem raised in this research is how the visualization of the Wuku Wukir batik motif is adapted from Pawukon. This research aims to identify Wukir and realize it in industrial design. This research uses a descriptive qualitative method, with data collection techniques through literature study, observation, and documentation. Data analysis was conducted descriptively to record the transfer of form from the textual calendar of Pawukon into the visual concept of the Wuku Wukir batik motif with double diamond theory. The result shows that Wuku Wukir can be adapted into a digital batik motif design without leaving the original cultural content. This research concludes that the visual transfer of Pawukon into the Wuku Wukir digital batik motif has excellent potential to be developed in industrial product design, contributing to cultural preservation in Indonesia.

Key words: Pawukon, wukir, industrial product design, Double Diamond, digital batik

INTRODUCTION

The topic of the Pawukon almanac in this study was chosen based on several essential backgrounds related to cultural, spiritual, and practical aspects of Javanese society. Raden Wukir is a mythological figure known for his wisdom in

puppetry. As the eldest son of Prabu Watugunung, he has a significant position in Javanese stories and traditions. In the traditional Javanese calendar system known as Pawukon, Raden Wukir inspired the third wuku, Wuku Wukir. This wuku depicts wisdom and symbolises myth thick with local Javanese cultural values. Although it has excellent symbolic potential, the Wuku Wukir motif has been widely used in commercial product design.

As an effort to preserve cultural heritage, the Wukir motif was adapted into the form of digital batik. This innovative step seeks to revive the wisdom and beauty of Javanese culture in a more modern form accessible to the broader community. This digital batik design adds to the richness of batik art and introduces local values into a more global creative industry. Several kinds of literature are used in this study, including the discussion of the History and Development of Pawukon. (Iswara, 2009) This article discusses the origins and development of the Pawukon calendar system, which the Javanese people have used for centuries. A discussion of the structure of Pawukon, including wuku, dina, and market, as well as their use in daily life, is elaborated in depth.

In a discussion of the structure and function of the Pawukon, Suwito explained that the structure of the Pawukon calendar consists of 30 wuku, each of which has a unique name and characteristics. This article discusses how Pawukon determines good and bad days in Javanese tradition. (Suwito, 2015) The philosophical and social meaning of Pawukon is specifically substantively extracted from a journal entitled "Philosophical Meaning in the Pawukon Calendar". This study examines the intellectual and symbolic meaning of the Pawukon calendar in the context of Javanese culture. (Widiastuti, 2018) It was also discussed how this calendar system reflects the cosmological views of the Javanese people. Meanwhile, the discussion of Pawukon in the Modern Context, a book entitled Pawukon and Its Relevance in the Modern Era, explores the relevance of the Pawukon calendar in the modern era, especially how contemporary Javanese society integrates this traditional calendar with the international calendar system that is more commonly used today. (Santosa, 2020) The History

and Origin of Pawukon are discussed in the book Kedjawen. This book examines the history of the development of the Javanese calendar, including the origins of the Pawukon calendar system that has existed since the time of the kingdom in Java. The Pawukon calendar is a dating tool and an essential part of Javanese culture and tradition. (R.M.Ng. Poerbatjaraka, 1940)

The discussion on how to design a product design, related to the Double Diamond theory as one of the approaches to developing industrial products; Magda's thinking in her paper "The Double Diamond Model: In Pursuit of Simplicity and Flexibility" that Double Diamond was created through extensive research on the methodology used by designers in large companies. This model outlines the design process in four phases: Discover, Define, Develop, and Ship. Each phase is designed to guide designers through a structured yet flexible approach to problem-solving and innovation. (Magda et al., 2022)

Furthermore, in the presentation "Wicked Strategies: Comparing Evolved Double Diamond for Strategy Creation for Wicked Problems in Service Design," it was stated that it emphasizes a structured approach to problem-solving through four phases: Discover, Define, Develop, and Deliver. Evolved models are adept at tackling the intricacies of evil problems by allowing for iterative refinement and flexible adaptation during the design process. (Kotaniemi et al., 2023) The book "Analysing the Double Diamond design process through research & implementation" (Gustafsson, 2019) explains that the Double Diamond process consists of four phases: Discover, Define, Develop, and Deliver. Each phase is detailed to show how they contribute to the overall design process. The research also offers essential insights for budding designers, especially those in an ever-changing market. Although unrelated to digital batik design, these studies can provide insights into how the Double Diamond model is used in industrial product design, exploring its flexibility and application in various design projects. From the approach of multiple sources above, the research and design entitled Calendar Pawukon Wuku Wukir as a Motif for the Design of Digital Batik Industrial Products has

the dimension that the creation of innovative digital batik designs based on traditional motifs from Pawukon, especially Wuku Wukir, deserves to be continued.

This research provides a model for cultural heritage adaptation into the creative industry, supporting cultural preservation through innovation and technology. Furthermore, the central gap between the literature review and this design is that the source of the manuscript focuses more on documentation and historical-cultural understanding. These library sources contribute to preserving and documenting cultural knowledge, while Wuku Wukir's research offers a new way to appreciate and utilize traditional motifs in a modern context. The visualization of Wuku Wukir focuses on practical applications and design innovations in the digital batik industry.

RESEARCH METHOD

The method section is a crucial component. It explains how the research is carried out. Here are some of the main contents of the method in a study:

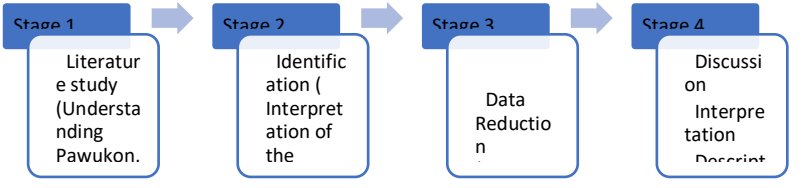

Figure 1: Research stages
Source: Research Team 2024.

Research Design

Research design refers to the overall framework used to conduct research. Type of Research: this study uses a qualitative descriptive approach. Research Approach: using content analysis, where wuku in the Pawukon Almanac is the object of research.

1. Population and Sample
2. Population: Pawukon Almanac located at the Radya Pustaka Surakarta Museum Jl. Slamet Riyadi No.275, Sriwedari.

3. Sampling: The sampling method from the population, the selection of wuku objects, uses the purposive sampling technique by determining the previous criteria.
4. Research Instruments.

Data Collection Tools: Instruments used to collect interviews and observation data. Validity refers to the extent to which a measuring tool or research method measures what is supposed to be measured. Content Validity is used as an instrument for this research. This technique measures the extent to which an item in a measuring instrument can cover all aspects of the measured concept.

This method can also be determined through expert judgment, which evaluates whether the items in the measuring tool cover all relevant factors.

1. Data Collection Procedures
2. Data Collection Steps: a detailed description of how the data will be collected is taken from the Radya Pustaka library, Mangkunegoro Palace.
3. Time and Location of Data Collection: The research was conducted in Surakarta in February 2024.
4. Data Analysis Technique: data Analysis Method Factor Analysis (Factor Analysis) is used to identify hidden structures in data by grouping correlated variables.

Design Proces

The Double Diamond theory used in this research and design is the brainchild of the UK Design Council, which was introduced in 2005. This model was created after an in-depth study of the design process used by various large companies. Richard Eisermann and Clive Grinyer were two key figures in the development of this model. The goal of the creation of Double Diamond was to provide designers and other stakeholders with a clear and easy-to-understand visual framework, facilitating the design process from initial concept to final implementation. (Magda et al., 2022)

Four phases in the design process of the double-diamond framework (Figure 1):

1. Discover/Research the phase of finding problems. Output: The results of the research, documentation, and findings are unstructured.
2. Define / Synthesis is the phase of analyzing the problem. Output: A summary of what needs to be improved, including any emerging research questions or strategies.
3. Develop / Ideation is the phase of presenting possible solutions, including evaluation at the end, to determine the selected solution. Output: Ideas, concepts, visions, initial prototypes.
4. Deliver/Implementation is the phase of implementing a suitable solution to solve the problem, including the Build/Prototype process.

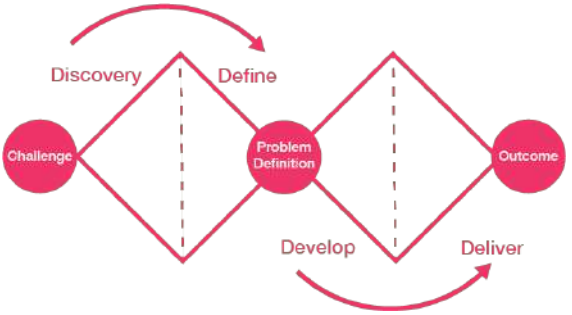

Figure 2. Four phases Double Diamond Model.
Source: https://mgearon.com/ux/double-diamond-model/

Table 1. Wuku Wukir visual data

			
Wuku Wukir 1	*Wuku* Wukir 2	*Wuku* Wukir 3	*Wuku* Wukir 4

Source: Research Team 2024.

Table 1 Translate the illuminations that frame the text:

Transfer from Script Table 1 Column 1 into Javanese	Language Translation from Javanese to Indonesian
[27] Dite Legi Wuku Wukir kang lumampah, kala ginelar sami gambar candrane sadaya.	Hari Minggu Legi, Wuku Wukir waktunya mulai berjalan, bila dijelaskan dengan gambar semuanya sebagai berikut
Candrane nuju gunung asri. Larangane ing Dipati, tegese yen dinulu ewuh kelakuhane, seje lahir batine. Yen dipeksa ora ana suwalane. Setibane kudu amrentah sepadhane jalma, tur kajen keringan, akeh kang dhemen. Rada kagungan, kumaluhung, kuminsun. Lengus, agedhe angkuhe, Lumuh asor dhirine, kudu ameryayi.	Perumpamaannya bagaikan gunung yang indah. Pantangan bagi Adipati, artinya bila dirasa kelakuannya tidak sopan, berbeda antara lahir dan batinnya. Bila dipaksa tidak bisa menghindar. Sewaktu-waktu memerintah sesamanya, dia terhormat, sehingga banyak yang menyukainya. Agak sombong, merasa paling mampu dan bisa. Pemalu, sangat angkuh. Rendah budinya, karena selalu merasa sebagai priyayi.
Dewane Sangywang Bethara Mahayekti.	Dewanya Sangywang Bethara Mahayekti.
Kayune nagasari.	Kayunya : Nagasari.
Gedhonge ngarsa.	Rumahnya di depan.
Kang sarta angadhep toya ana jembangan.	Menghadapi air di dalam lembangan.
Manuke manyar.	Burungnya : Manyar.
Sangywang Bethara Mahayekti wateke mendhita, meryayi, teberi prihatin, aneng sepi, agedhe atine, ora dhemen jagongan lan wong akeh, ambek kumingsun .	Sangywang Bethara Mahayekti berwatak pandhita/guru, seperti priyayi, rajin prihatin, suka menyepi, percaya diri, tidak suka berkerumun dengan orang banyak, karakternya sombong.
Kayu nagasari : awuled, akeh kang dhemen,aredi lungguhe, awangi ambune, tur pinilala wong agung, nanging kedhik gawene.	Kayu Nagasari : kuat, banyak yang menyukai, berada di gunung, baunya harum, dipelihara para pembesar, tetapi sedikit manfaatnya.
Gedhong aneng ngarsa : ber budine, abot tata, ...kasugihane,.....sugih kaya.	Rumah di depan : budinya baik, mengetahui tatakrama, kekayaannya, melimpah.
Kang toya jembangan : ajang karsane, adhem parentahe, kang sarta lumintu begjane, ora kurang sandhang pangane.	Air Jembangan : kemauannya baik, perintahnya menyejukkan, rejekinya mengalir terus, tidak kekurangan sandang pangan.
Wuku Wukir yen manggih bilahi, den kaniaya.	Wuku Wukir, mengalami musibah celaka, bila dianiaya.
Sidhekahe : sega wuduk, amung beras sapitrah, ulame pitik putih kang mulus sawayahe, den lembarang lan endhog , krupuk, sambel poncot, lan janganan warna piptu.	Sedekahnya : nasi uduk satu fitrah, daging ayam putih polos yang sudah berumur, dibuat wutuh dan telur, krupuk, sambel poncot, dan sayuran tujuh macam.
Dungane : mulya, umur, selamet.	Doanya : doa kemuliaan, doa umur, doa selamat.
Selawate : seprapat dhuwit anyar.	Uang wajib, selawat, seperempat uang baru.

Define / Synthesis

At this stage (Table 2.), the design team takes all the insights and data collected during the Discover phase and begins to organize them to identify patterns, themes, and critical insights. The main goal is to sift through information and craft a clear and focused statement of the problem. Some identifications found from the post-discovery stage are used to recommend the following plan or stage. The recommendations at the synthetic stage are implemented in the description presentation, which contains how visual elements will be realized, including the question of how the strategy will be raised.

Table 2. Visual description *of* *Wuku* Wukir calendar Objek Visual	Description
	This figure is the main motif in this batik motif. The figure's movement on the Pawukon fiber barely undergoes a visual transformation, which emphasizes the character of the Batara Mahayekti figure. The details of the distillation appearance and the costume part is simplified to adopt the three cecek three isen. The figure is positioned not from head to toe but only from the head to the torso. The visual form of *Pawukon fiber*, Wuku Wukir in coloring is more contrasting, not following the coloring scheme in Solo batik, namely brownish, and dark brown.
	The object of the house in *pawukon* is transformed into the main object of the batik motif which is metaphorized as good morals, knowing the manners, wealth, and abundance. The coloring of the roof of the house from green is transformed with yellow and black.
	The figure of Raden Wukir in *Pawukon* fiber has a rather arrogant character, feeling the most capable and capable. Shy, very arrogant. He is humble, because he always feels like a priyayi. Coloring figures does not undergo a transformation in coloring because it is to strengthen the character of a figure.
	The object of the tree with the Nagasari type of wood is metaphorized as strong, many like, being on the mountain, smelling good, maintained by the dignitaries, but with little benefit. The green color is not transformed into another color, only the stem part is dyed with moss green.
	The visual object of *Pawukon fiber* is in the form of a Manyar bird object, small in shape, metaphorized as a useful and clever bird, in accordance with expectations, and its partner is patient. This visual object undergoes a visual transformation by being simplified and made repetitive with an up-and-down composition on the batik and placed along the horizontal.

Source: Research Team 2024.

In creating batik compositions with Pawukon motifs, artisans must carefully arrange various main objects and supporting elements on batik fabrics. This process is inseparable from the deep attention to the aesthetic values that

want to be realized. When a batik designer or artist composes these elements, they focus on the visual arrangement and consider various other aspects, such as harmony, balance, and cultural symbolism that they want to present. These elements are then assembled to create a work of art that is visually appealing and rich in cultural meaning and relevance. Thus, batik art is not just a visual product but a complex expression of cultural heritage and traditional values passed down from generation to generation.

According to Dharsono, understanding aesthetics is not just about appreciating beauty; it also involves an in-depth study of various art forms, including design elements and principles. This understanding involves exploring how visual elements, such as lines, colours, shapes, and textures, can be arranged effectively. (S. Dharsono, 2016) The visual structure can be formed by carefully arranging these elements, along with applying design principles such as balance, contrast, rhythm, and proportion. In creating artwork, artists view every part of their work—from the smallest element to the overall composition—as a cohesive whole. This approach ensures that each component harmoniously interacts with each other so that the work can function optimally, conveying a specific message or emotion to the audience.

Thus, art not only plays a role as a visual object but also as a medium of communication that can touch and inspire the audience through its richness of meaning. In his book entitled Feeling and Form, Langer describes artwork as a form of expression that is often identified with art symbols. According to Langer, the symbol of art in each work not only functions as an aesthetic object but also has a symbolic role that goes beyond its surface functions. Each piece of art, in Langer's view, acts as a symbol that conveys deeper meanings and emotions. This means that art is to be seen or heard and to be felt and understood symbolically. Art symbols express ideas, feelings, or experiences that may be difficult to express through words. This allows art to communicate on a deeper level, allowing the viewer to connect with a work's emotional and intellectual aspects, making art an effective and meaningful means of

communication between the artist and their audience. (Langer, 1957)

According to the basis of aesthetic thinking and symbols described by Langer, there is a concept of discursive symbols that refer to symbols that can be understood rationally and analyzed through logical statements in stages. This means that each symbol in the artwork has a meaning that can be approached logically and structured. In this context, the visualization of the symbolic composition of wuku Wukir involves a visual form consisting of elements such as wuku itself, significant figures, and various accompanying equipment. Each component is described in detail, emphasizing its meaning, including the significance of each word, such as "Wuku," or certain attributes with a symbolic meaning. This includes why certain visualizations are used and how these elements convey a deeper meaning.

In the past, humans had a very close relationship with nature, and many of the symbols in Wuku were inspired by natural phenomena. Wuku serves as a sign of life that helps people determine the right time for activities such as farming and harvesting. In addition to wuku, other visual symbols displayed include gods, fish, trees, birds, water, and other natural symbols that symbolize different aspects of life. In this visual representation, are not only the figures of gods and wuku important, but also the completeness of the elements of the Pawukon composition, which includes various components such as trees and birds. In addition, other objects are also depicted, such as houses, banners, water containers, and weapons, all of which contribute to the symbolic perfection and depth of the composition. These symbols are not just decorations but an integral part of a visual narrative that conveys stories and deep cultural meanings.

Develop/Ideation

As a composition composed of various elements, the composition of the Pawukon manuscript can also be studied from the explanation of the composition as an arrangement consisting of a pattern arrangement. The visual composition consists of the central motif, the filler motif (intertext), and the

pattern consisting of filler materials. Basic motifs are essential elements in the form of specific images or shapes. As one of the classical art forms, this subject includes philosophy or teaching. Supporting motifs, elements created on particular figures or shapes, are made to fill the space between the central motifs. This motif serves as a decoration. The filler motif (isen) is an element or elements that decorate the main or supporting motif. (Dharsono, 2016).

The composition of Wuku Wukir is a harmonious blend of wuku figures, birds, trees, houses, banners, water containers, and other elements in the form of flowers. Despite the object's location not being overtly visible, its equal distribution across the entire image area creates a sense of balance and harmony that seamlessly integrates with the space or image media used. Though not adjacent, the orientation of the gods' faces and the bird figures fosters tranquillity and interaction between the two objects. The visual composition of the central motif is the character of Raden Wukir carrying a weapon to stab the keris while facing Batara Mahayekti.

The filler motif (interlude) is depicted with 4 (four) Manyar birds perched. The isen/filler motif is manifested in a dense plant pattern, namely Nagasari branches and trees, as well as hanging flowers and fruits. This motif serves as a decoration. Supporting motifs are depictions of house buildings, banners, and water containers. The character's essential character is visualized in the pattern of the shape and colour of the face or face, namely in the visualization of the eyes, nose, mouth, face colour, and facial position, as well as in the position and comparison between elements. The character of Raden Wukir is described as sitting cross-legged facing the right, with a stout body and a "*singset*" body (looks thin but dense with muscles). Raden Wukir wore a crown-shaped headgear (*irah-irahan*) with accessories including *makutha, topong, songkok, supit urang loop, rivet loop and gimbalan hair*. Wearing clothes (*dodhot,* wet clothes worn by the bride and groom during the *Panggih* ceremony at Mangkunegaran Temple) is a type of gallantry, more often called "jangkahan". (Sunarto, 2000)

Judging from the direction of his view, the figure of Raden Wukir is facing to the right, meaning that Wukir has good dignity. (Junaidi, 1994). Raden Wukir is depicted in light brown, this is as it has become a reference in color psychology that the color is to give an impression of grace and elegance. (Banindro, 2018) His eyes are wide, which, in the language of the puppet, is called "eye of the arm," which means unpretentious, virtuous, agile, challenging, and always standing on the right side. His lips are described as "mesem mouth", which is defined with the condition when mesem or smile, as a sign that wuku Wukir is a person who is very pleasant if you get to know him at first glance. (Mulyono, 1987)

Table 3. Wuku Wukir Visual Digital Transformation Transformasi Visual	Description
	This figure is the main motif in this batik motif. The movement of the figure on the Pawukon fiber barely undergoes a visual transformation, this is to emphasize the character of the Batara Mahayekti figure. The details of the distillation appearance, and the costume part is simplified to adopt the three cecek three isen. The figure is positioned not from head to toe but only from the head to the torso. The visual form of Pawukon fiber, Wuku Wukir in coloring is more contrasting, not following the coloring scheme in Solo batik, namely brownish, and dark brown.
	The object of the house in Pawukon is transformed into the main object of the batik motif which is metaphorized as good morals, knowing the manners, wealth, and abundance. The coloring of the roof of the house from green is transformed with yellow and black.
	The figure of Raden Wukir in Pawukon fiber has a rather arrogant character, feeling the most capable and capable. Shy, very arrogant. He is humble, because he always feels like a privayi. Coloring figures does not undergo a transformation in coloring because it is to strengthen the character of a figure.
	The object of the tree with the Nagasari type of wood is metaphorized as strong, many like, being on the mountain, smelling good, maintained by the dignitaries, but with little benefit. The green color is not transformed into another color, only the stem part is dyed with moss green.
	The visual object of Pawukon fiber is in the form of a Manyar bird object, small in shape, metaphorized as a useful and clever bird, in accordance with expectations, and its partner is patient. This visual object undergoes a visual transformation by being simplified and made repetitive with an up-and-down composition on the batik and placed along the horizontal.

Source: Source: Research Team 2024.

Develop / Ideation

The develop stage, a crucial phase in problem-solving, aims to explore potential solutions after the problem has been clearly defined. At this stage, the team focuses on developing various ideas and concepts to meet the needs that have been identified.

Divergent: This stage is divergent, which encourages creating as many ideas and solutions as possible. The focus is on creativity/collaboration and exploratory/iterative.

1. Collaborative: Engage various stakeholders to gain diverse perspectives and improve the quality of ideas.
2. Iterative: Involves rapid iterations to test and modify ideas continuously.

Brainstorming: The brainstorming session is the core of this stage. Contains an explanation of thoughts on how digital batik will look later.

1. Design teams are encouraged to generate as many ideas as possible without judging or distilling ideas in the early stages.
2. Mind mapping, role-playing, and brainwriting are often used to spark creativity.

Prototype:

1. Turn an abstract idea into a rough sketch or a simple prototype.
2. Prototypes can be physical models, digital wireframes, or mockups that help visualize concepts.

Figur 3. *Wuku* Wukir in a classical puppet visualization.
Source: Research Team 2024.

Figure 4. Wuku *Wukir* sketch batik layout
with the visual composition of Raden Wukir on the left and Resi Batara Mahayekti on the right.
Source: Research Team 2024.

Deliver / Implementation

The Double Diamond model is the last phase that focuses on implementing and launching the final solution. The goal is to ensure that the solutions that have been designed and developed can be implemented effectively and positively impact the goals that have been set. They are applying the results of development into real solutions ready to use or access by end users. Ensure the solution works according to the design and meets the user's needs.

Figure 5. Wuku Wukir's digital batik design is made with computer graphics.
Source: Research Team 2024.

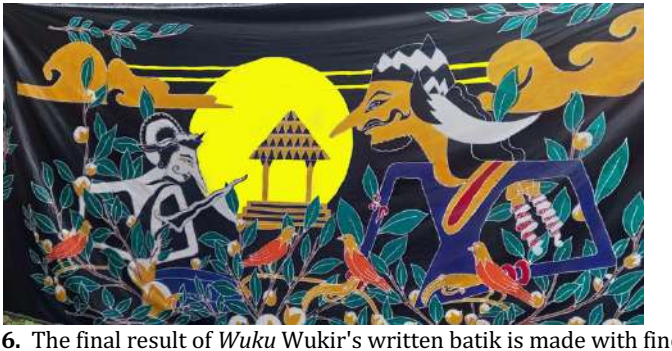

Figure 6. The final result of *Wuku* Wukir's written batik is made with finely written batik techniques.
Source: Research Team 2024.

Figure 7. The selected motif is the Pawukon Wukir digital batik design.
Source: Research Team 2024.

DISCUSSION

With a visual composition of wuku Wukir (Figure 4), Batik is inspired by a story from Pawukon fibres, namely Raden Wukir, the third wuku of the Pawukon calendar. (Table 3*)* Raden Wukir got his name from Prabu Watugunung's eldest son. Individuals born in the Wuku Wukir period are believed to have unique and special character traits. They are considered not only to possess certain qualities but also to carry with them a prophecy about their life journey.

Their lives are expected always to be influenced by courage and wisdom, traits that they inherited from noble and authoritative ancestors. This ancestral heritage not only shapes their essential character but also guides them in facing various challenges in life. Every step they take is believed to be filled with profound wisdom, which allows them to overcome obstacles and achieve success with integrity. Therefore, being born in Wuku Wukir is considered to bring blessings, good luck, and the responsibility to maintain the noble traditions, which are passed down from generation to generation.

In the book Betaljemur Adamakna (1993) In traditional Javanese visualization, wuku Wukir is described as a period shaded by a protective deity, namely Batara Mahayekti. This god is believed to give notable influences and characteristics to those born in this wuku. One of's main features of wuku Wukir are its outstanding generosity and ability to be an exemplary leader. Individuals born in wuku are often seen as generous and wise figures who can lead justly and set an excellent example for others.

Despite the positive traits, wuku Wukir also presents certain weaknesses that should not be overlooked. For instance, there is a tendency to always want to be in control, which may not always be conducive to harmonious social interactions. Furthermore, individuals born under the influence of wuku Wukir may exhibit a propensity for infidelity and a habit of exaggerating their wealth or achievements. This showy nature can lead to conflicts if not managed wisely. Therefore, it is crucial for those born in wuku Wukir to be cognizant of their weaknesses and strive to balance these traits in their daily lives. (Soemodidjojo, 1993).

Wuku Wukir, often metaphorized for its botanical characteristics, shares a profound connection with the life of plants and trees. The Nagasari tree, a metaphysical wood embodying this wuku, possesses the power of 'life practice,' the art of living daily life with purpose and mindfulness. This tree, a symbol of life's continuous evolution, also represents resilience and unwavering strength in the face of life's adversities, inspiring us with its ability to endure.

In addition, wuku Wukir is also known for its nature, which is often concerned or shows an attitude of sensitivity to difficulties and suffering, both in oneself and others. In this case, the symbol of wuku Wukir is 'becik,' which means to look good or attractive from a distance, but when approached, it is often deceptive or deceiving. This reflects the nature of duality, where something that looks perfect may only sometimes be so when viewed closely. This duality serves as a reminder of the need for caution and discretion in judgment, as things are not always as they seem, and what appears perfect from a distance may reveal imperfections upon closer inspection.

The water element in front of the Wuku Wukir symbol represents the concept of 'Prada,' a symbol of sincere and selfless giving without expecting anything in return. This water, a reflection of the profound nature of generosity and sacrifice, serves as a poignant reminder of the importance of supporting and assisting others with sincerity. This metaphor paints Wuku Wukir as a complex blend of apparent kindness, a readiness to sacrifice, and a crucial lesson about looking beyond the surface, leaving us in awe of its profound nature. (n.n, 2022).

Raden Wukir is depicted with a calm face, radiating a sense of peace and harmony. His face is bright and his body light brown. The main character that accompanies the birth of Wuku Wukir is his generosity, a trait that balances his considerable heart's desire. He is often seen wearing a headband, a shirtless body with clothes, stretching cross-legged, sitting cross-legged, and carrying a self-protection weapon in the form of a Pudhak Sategal keris.

Resi Batara Mahayekti is depicted in a beautiful brown dress, symbolizing her firmness and wisdom. Her headgear, a *Jamang Sungsun* crown, and a red sash with gold edges,

symbolize the light of the wise. The entire picture is composed symmetrically, with the moon in the middle of the field, house buildings, and water places covered with lush forest foliage of Nagasari trees and Manyar birds.

This research successfully adapted motifs from Almanac Pawukon Wuku Wukir into the design of Pawukon digital batik products, showing that traditional elements can be integrated into modern design innovations. This proves that cultural values derived from local traditions, especially those in Surakarta Palace, are still relevant and can be empowered in the context of today's creative industry. The use of digital technology in batik design enables the creation of more varied and complex motifs. Thus, digital batik can meet the growing market demand and present an attractive product to younger generation consumers who may not be interested in traditional batik.

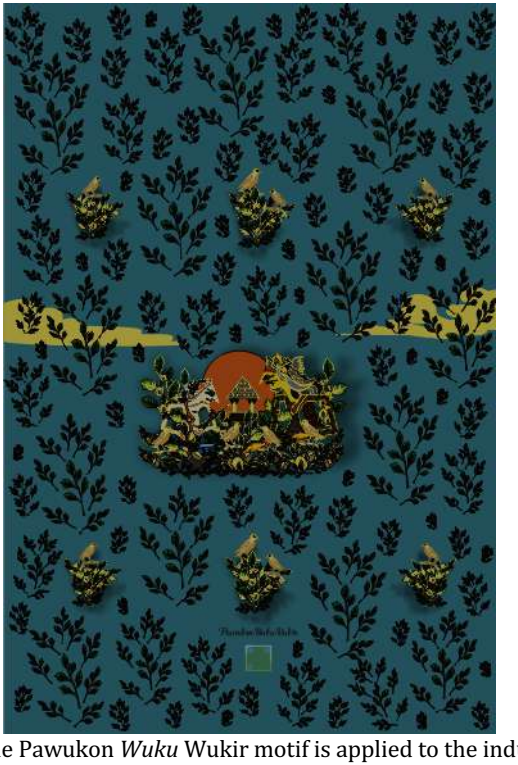

Figure 8. The Pawukon *Wuku* Wukir motif is applied to the industrial

design of the bed cover set.
Source: Research Team 2024.

CONCLUSION

This research contributes to cultural preservation by documenting and utilizing traditional knowledge as design inspiration. This helps to keep cultural traditions from disappearing and remain part of the local cultural identity. The results of this research provide insights and recommendations for creative industry players to continue to look for ways to integrate traditional values with modern technology. Product development that combines traditional elements with technological innovation can increase product competitiveness in the global market.

The study acknowledged limitations regarding sample coverage and broader application of the design. Therefore, further research is needed to explore other uses of Pawukon motifs and test the successful implementation of this design in various market segments. This research emphasizes the importance of collaboration between cultural heritage and modern technology in creating products that are not only innovative but also culturally meaningful. The creative industry can take inspiration from these findings to continue developing products that respect tradition while meeting contemporary demands.

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MODULAR FASHION DESIGN FOR PETITE REGIONAL WOMEN IN BALI

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Abstract

Women with a petite body often face challenges in finding clothes that fit their size due to their shorter stature. In Indonesia, the majority of fashion products use international standard sizes, and petitesized clothing is still scarce, leaving petite women with limited choices in selecting suitable attire. The selection of ill-fitting clothing can also make petite women appear shorter than their actual height, leading to a lack of confidence. Some fashion industries offer fast fashion for petite women, but this may contribute to the potential consumerism of fast fashion targeting petite women. In addressing this issue, sustainable fashion through modular design can help petite women feel confident in various styles with just one garment, without contributing to the accumulation of fast fashion waste. The research conducted is of a qualitative descriptive nature, involving data collection through questionnaire activities and environmental and community observations, along with a literature study. The purpose of this research is to understand the process of designing modular fashion applied to petite women's clothing. This design approach results in multifunctional fashion products using modular design specifically tailored for petite women.

Key words: petite women, modular design, sustainable, fast fashion

INTRODUCTION

Bali is a tourism zone with The fashion industry continues to grow rapidly. More and more people are interested in the world of fashion, creating that demand high for clothing of any style and size different. Every human being has a form different

bodies and heights. Indonesia entered into the list of countries with tall people shortest in the world with an average of 157.9 centimeters or 62.2 inches. Indonesian women has an average height of 154.3 centimeters. (Nurhanisah, 2024) In Bali region, ethnic Balinese have an average height of 156.4 centimeters. (Linasari, 2017) Therefore, the majority of people, especially Balinese women is a petite woman. In general, the term 'petite' used to refer to a person who have below average height. In female context, petite refers to women who has a height of less than 162 cm (5 4 inch feet). (Enrico, 2016) Woman with petite body have different body proportions than women with taller height, with features such as narrower shoulders, a smaller waist, and more legs short. (Fatimah , 2018)

Using standard size or all size size so that women with petite body shape often face the challenge of finding suitable and comfortable clothing. Although the fashion industry continues to flourish, The challenge of finding a suitable dress for a petite woman remains a significant issue..In the fashion management and marketing journal on fashion involvement research, Pre-buy satisfaction and clothing needs on petite-sized clothes, These consumers, the petite-sized women, show a great lack of dissatisfaction to the available fashions. Based on the comments of the responders, a woman short and small has more problems with outfit selection. (Khan, 1999)

Many clothing stores did not provide enough variation of measure for women with a body petite. And the design is a model based on available to a larger body size, leaving the women petite with limited options. Petite woman forced himself often buy clothes in a standard so petite woman to adjust a garment to tailor in addition to cutting costs, smoothing, or change designs clothing to fit the petite of a lady. It is not just spend the time and money, but also created discomfort and frustration. In addition, several models petite not suitable for a woman wardrobe and made them more visible short a petite and makes ladies are not confident. There is an era now, Petite clothes are generally available at the mall. One of them is H&M. But, H&M dress is a fashion fashion fashion with only 3 weeks cycle. (Lenawati, 2021) Fast fashion delivers faster time, In just a few weeks, the fashion development process from design to

dress is ready to wear. Other than that, The fashion fast offers a large number of different styles of clothing.This causes fashion waste to increase rapidly. There are two things we can do about fast fashion, which is with reuse and subtraction. In that case, the author takes the opportunity to reduce using the principle of slow fashion, which is to develop modular fashion design intended for women petite.

Modular fashion design is an innovative approach to making clothing that allows wearers to create different styles and appearances by combining parts of clothing that can be separated and combined. In this design, each piece of clothing is designed in such a way that it can be paired with another section, create useful clothes and can be adjusted to the user's needs and preferences. In that case, modular fashion presents creative freedom for petite women. By having various parts of clothing that can be combined, Petite women can create different styles for different opportunities without having to have a lot of clothes. This not only provides practicality in dress management, but also supports sustainable environments by reducing waste and textile waste.

Modular fashion design also supports the idea of diversity in mode, because it allows each individual to express of the problems that have arisen. In this further research it will either be discussed or studied on modular fashion design designed for women who in this case can at least make it easier for petite women to find suitable clothing for women and modular clothing that can be associated with many fashion styles without speeding up the development of fast fashion which is bad for the environment. Other than that, This research aims to make people realize that every woman has a different body shape. Especially Petite women and this problem cannot be ignored. The design of this dress also aims to support the petite woman to show confidence even though she does not have an ideal body and educate Petite women to not insecure with her body.

Petite woman fashion petite size is the size of the specifically designed for women with below average height, usually 160 cm (5 feet 4 inches) or less. A petite having due proportion adapted to smaller body, including long arms, inseam pants, and broad shoulders.Here are the standard

measure petite woman Indonesia.

Table 1 (1) Petite Size Indoensian Women

Bust 84 cm
Waist 69 cm
Hips 95 cm

Source : Felicia Merida Enrico, 2024

Petite fashion style is a term used in clothing that refers to certain height range size made to fit small with them. Style of dress petite need to pay attention to a silhouette, a cloth, a long garment, a combination of colors, and pieces of clothing as some kind of dress make a woman petite little more. According to literature from the data collected and give tips on fashion stylish and fashion designers from platform youtube, the following is a selection of appropriate for petite women fashion. Women's color petite is more recommended using monochromatic clothing. Monochromatic is the kind of color theory defined by a series of colors that all have the same rona, Scaled from light to dark. (Pelzel, 2024) Monochromatic colors will make the body's illusion higher. On the contrary. If using color contrast the body's illusion will look severed so it will look shorter.

In the election for women to fashion a petite, attention should be given to a number of considerations. First, a vertical or a longer line may be elongated visual impact, creating the illusion of height required. In addition, avoid motive too large or complex, because it can make tiny and posture. On the other hand, choose a smaller or small scale to create the impression that is lighter and balanced. Avoid clothing with too many details can make a too crowded. Concentrate on the details simple design enriching appearance without distract attention from the body.

The petite women dress to a silhouette involving chose to support smaller proportion of the body. And the shorter or crop and subordinate highwaist so the legs look more level. Avoid clothing that is too big or too small. A garment fitting fine at the shoulder, the waist, and long legs can create a display that is more balanced. It should be noted also, clothing is too long can

make the body appear shorter. Select pants, a skirt, and dresses in having long, for example, not too long trousers and skirts reaching the best part of the leg. Avoid also selected fashion too wide or expands because they can make the body looks short and become larger, one of them choose trousers with a straight line or a little flares could give the impression of the foot longer.

RESULT

Modular Fashion System

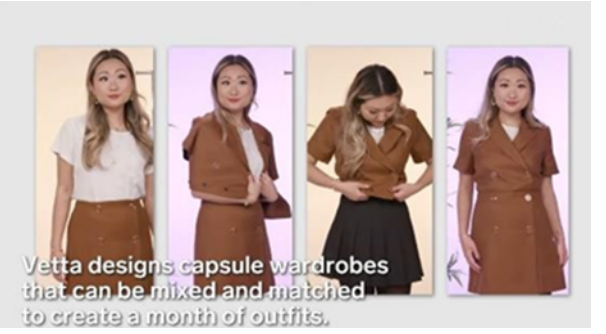


Figure 1 Modular Fashion System
Sourcer : youtube “Insider Art” 2024

Modular design is the product of certain elements that simultaneously as module universal form a new system that produces different variations, the same function, and performance products. Modular design can dismantle bagian-bagian clothes in different and make clothes no longer viewed as product of incomplete, but overall consisting of several modules can be integrated as shareholder with probability without end. (Chen 2018) In modular fashion using Mining as a link in each module in a fashion such as: (1) hole buttons, (2) snap button, (3) rope, (5) relining. These lentils are used to install and remove certain parts to turn one kind of outfit into a different model of clothing, Like long pants that can turn into shorts because the bottom of the pants that can be taken off. (Natasya, 2022)

Fashion Trend 2024

Predicted that the trend is the process of color who con-

front creativity, research, and analysis of data.Wesnxcoloro and pantone color institute of wama in forecasting industry was the leader.To the autumn color 2024, the dominant choice for includes classic autumn shades ranging from red berries that warm, orange, and purple until the new modern money will make the is unique. (thepatternedit, 2023)

Figure 2 Fashion Tren 2024
Source: pinterest.com, 2024

Other than color, some fashion items are also expected to trend during 2024. One of them is stacked tape. Gen z and millennials are predicted to be decorating shoes, clothes, hair, until his jewelry with ribbons. The band will use a sticky accent. The use of such bands can create a sweeter impression. Pinterest predicts, in the next year, the ribbon ornament will be scattered for everyone. Almost all fashion items will be equipped with ribbon decorations. (Zarawaki, 2024)

H&M atau Hennes & Mauritz AB

H&M atau Hennes & Mauritz AB,is a global fashion derived from Sweden.Founded in 1947, erling persson who founded by headquartered in Stockholm, Sweden. (TBH, 2023) With thousands of stores around the world and online presence via websites and applications, H&M continues to be a popular

destination for consumers who look for modern clothing in the latest style H&M is known as one of the leading fashion brands that provides affordable clothing and accessories. This brand is famous for its trendy and inspired style of top fashion, while keeping a competitive price value. Product of H&M has a large size range which is xxs 3xl and size petite, quality as well as a variety of designs. But, H&M is one of the fashion fast brands that has a three-week cycle. This cycle is rated so fast that it can have a bad impact on the environment. In addition to that the majority of products h & m use synthetic materials that are difficult to parse and not good for skin health.

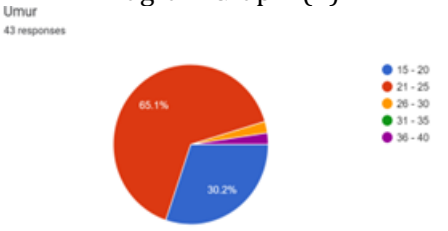
Convertible Racing Jacket

Convertible racing jacket is one of the product of lady lotus boutique brand. Brand would come from the united states and the people named Fei Hong. (Hong, 2023) The design of the modular concept model are taking a long and oversize jackets in the middle can be removed so that the crop to a jacket top and lower part of the jacket would be skirts so although separated between the upper and lower, fashion can be in use to look different. This jacket also has a lot of size range. That's size s xxl with standard size united states. However, standard size of united states larger than asia size especially in Indonesia which has a body tends to be smaller. Other than that, this jacket has a lot of details with large sizes that are not suitable for the Petite woman's use. The product also uses unfriendly polyester materials and is not good for skin health.

Questioner Data

In testing the description of this data, Researchers are trying to find out about the self-description, the challenge and hope of the Petite woman in choosing the fashion and the interest of the responder to the modular fashion design sample in this study. From the data collection results from the responder's response, with 43 responders using Google form or gform platforms spread out on the ground. This questionnaire was distributed from December 20, 2023 to January 1, 2024.

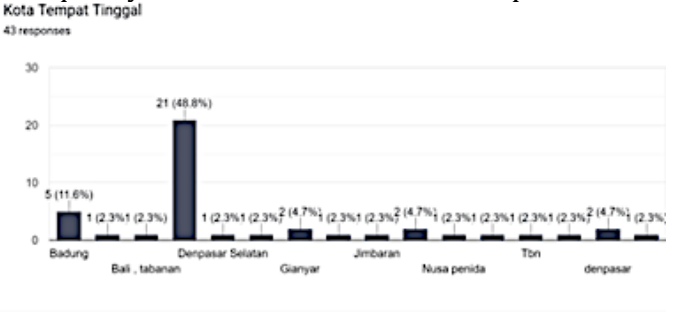
Diagram Graph (1)



Source: Personal Data, 2024

Frequency test data results show that the characteristics of respondents based on age i.e. with the age of 15-20 years as many as 13 people with a presentase of 30.2 %, with age 21-25 years as many as 28 people with 65.1% presentation, 26-30 years as 1 person with a presentase of 2.3 %, and age 36-40 years as 1 person with a presentase of 2.3 %. It can be concluded that the characteristics of the respondents based on the age of this study were dominated by respondents with the age of 21-25 as many as 28 people.

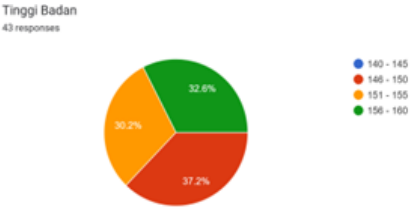
Charts the (1)
frequency based on residence of the respondents



Source: Personal Data, 2024

Frequency data results show that the characteristic responders based on their original area, Most domineering were the responders with the origins of the Denpasar, Where it's calculated manually. There are 24 people from denpasar and some of the responders came from outside Denpasar as many as 19 people as: Badung, Tabanan, Klungkung, Karangasem, and Gianyar.

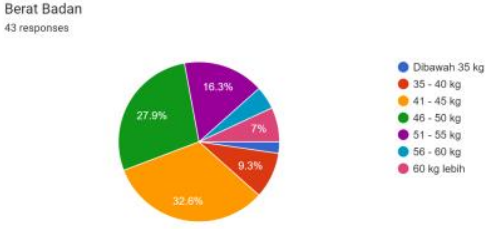
Diagram Graph (2)
Frequency test results based on response height



Source: Personal Data, 2024

Results from frequency data show that the characteristics of respondents based on the height they have is 140-145 cm with a presentase of 0 % (0 people), body height 146-150 cm with a presentase of 37.2% (16 people), body height 151-155 cm with presentase 30.2% (13 people), and height of 156-160 cm with a presentase of 32.6% (14 people). Can be concluded that the characteristics of the respondents based on height are dominated by height 146-150 cm with a presentation of 37.2% with the number of 16 people out of 43 people.

Diagram Graph (3)
Frequency test results based on the body weight of the responder

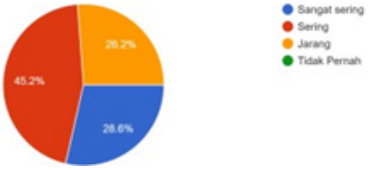


Source: Personal Data, 2024

The result of the frequency data shows that the characteristic of the responder based on the weight of under 35 kg is presentase 2.3 % (one person), weight 35 -40 kg with 9.3 presentase % (4 people), weight 41-45 kg with 32.6 presentage % (14 people), weight 46-50 kilograms with 27.9 presents % (12 people), weight 51-55 kg with presents 16.3 % (7 people), weight 56-60 kg with 4.7 presentation % (2 people), and weigh over 60 kg

with presents 7 % (3 people). It can be concluded that the characteristic of the responder based on weight is dominated by the weight of 41-45 kg with a 32.6 presentation of 14 people out of 43 people.

Diagram Graph (4)
Frequency test results based on difficulty in finding fashions according to height



Source: Personal Data, 2024

From the chart above shows all responders with presents 100 % or 43/43 responders have had difficulty finding clothes that fit height.And responders claim that it was never difficult to find clothes that fit your height with presents 0 % (0 person), rare 25.6 % (11 people), often 46.5 % (20 people), and very often have difficulty with 279 presentage % (12 people).

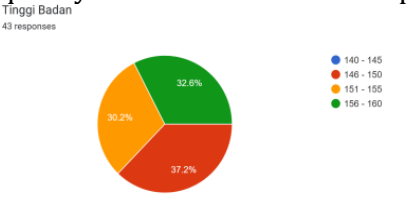
Log graph (1)
Frequency test results based on the responder's Residence

Source: Personal Data, 2024

The data showed that the frequency of karakterisktik respondents origin on which they live, most dominating is respondents with from other regions located in denpasar, where in the manual, there are 24 people from denpasar and for

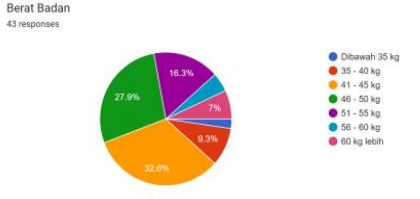
those who come from outside the denpasar as many as 19 people like: Badung, the district, Klungkung, Karangasem, and Gianyar.

Diagram graph (2)
Frequency test results based on response height



Source: Personal Data, 2024

Diagram graph (3)
Frequency test results based on the body weight of the source responder:



Source: personal data, 2024

Results from the data frequency show that the characteristic of the response based on weight that belongs to under 35 kg with 2.3 presentage % (1 person), weight 35-40 kg with 9.3 presentase % (4 people), weight 41-45 kg with 32.6 presentage % (14 people), weight 46-50 kilograms with 27.9 presents % (12 people), weight 51-55 kg with presents 16.3 % (7 people), weight 56-60 kg with 4.7 presentation % (2 people), and weigh over 60 kg with presents 7 % (3 people). It can be concluded that the characteristic of the responder based on weight is dominated by the weight of 41-45 kg with a 32.6 presentation of 14 people out of 43 people.

Graphic (4)
frequency test results based on the level of difficulty in finding clothes according to height

Source: personal data, 2024

From the graph above shows all respondents with 100% or 43 / 43 presentation of the respondents have ever had difficulty in finding clothes that correspond to height. And respondents stated never had any difficulty in finding clothes that fit the height with a presentation of 0 % (0 people), rarely 25.6% (11 people), often 46.5% (20 people), and very often have difficulty with presentation of 27.9% (12 people).

Log Graph (2)
Frequency test results based on difficulties once experienced when buying source clothing:

Source: personal data, 2024

The data proved that Petite women found trousers/skirts of inappropriate length. The second most followed by the length of a dress that does not match the body torso, the third arm length that doesn't fit, then the responder also added to the difficulty of buying a dress with an unsuitable waist. The many difficulties

that women face, Petite, prove that there are many things that need to be taken care of in designing clothes for petite women.

Charts the (5)
based on the results of the frequency of difficulties had ever experienced when buying clothes

Source: private data, 2024

The data proving that petite women more frequently finds/pants with long skirt ill fitting, followed by a second largest long torso is not in accordance with the, third long arm that is fitting, and respondents also menambahan difficulties in purchasing dress with the ill fitting the waist. The difficulties experienced by women petite proves that a lot of things that need to be considered in designing petite fashion for women.

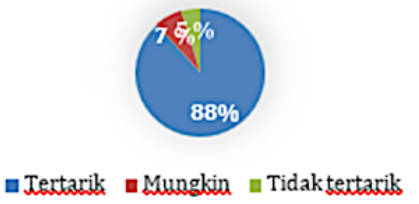
Log Graph (3)
Frequency test results based on the action of the responder when having too long clothes

Source: personal data, 2024

The data proves that the petite women prefer to cut clothes that are too long. The second most followed by folding too long a

garment, third combined with suitable clothing. Fourth let it go just like that, fifth in heels. And the last one didn't use it. Of the majority of the responders who chose to cut clothes, In the future, this will increase the waste of fabric in the fashion industry.

Diagram Graph (6)
Frequency test results based on responder's interest in modular dress:



Sources: personal data processed in 2024

The diagram graphs above show most responders with 88 presents % or 38/ 43 responders interested in using modular fashion design. And some of the responders said they might be interested in presentage 7 % (3 people), and is not interested in presentage 5 % (2 people).

Diagram Graph (7)
frequency test results based on modular fashions that wish to respond

Sources: personal data processed in 2024

Diagram graphs above show most of the responders with 65.1 % or 28/43 responders choosing to use casual/non formal modular fashion.And some of the responders chose a semi-formal modular fashion with 27.9 presents % (12 people), and

select a formal modular fashion with presentation 7 % (3 people).

Diagram Graph (8)
frequency test results based on modular fashion that respondents want to try

Source: personal data processed in 2024

From the graph above shows most respondents with presentation of 81.4% or 35 / 43 respondents chose. And a portion of respondents chose semi-formal modular fashion with a presentation of 27.9% (12 people), and choose a formal modular fashion with a presentation of 7% (3 people).

Figure (9)
Frequency test results based on environmental friendly fashion interests and long-term use

Source: personal data processed in 2024

From the diagram graph seen that almost all respondents (42 out of 43 people) are interested in environmental friendly fashion and long-term use and 1 of them mentioned not interested in environmental friendly fashion and long-term use.

Graphic (10)
frequency test results based on environmental friendly fashion interests and long-term use

Sources: personal data processed in 2024

From the graph above shows most respondents with a presentation of 58.1% or 25 / 43 respondents bought 1 4 fashions in a period of 3 months, 5 8 fashion with a presentation of 30.2% (13 people), more than 17 fashion with a presentation of 7% (3 people), 9 12 fashion with a presentation of 4.7% (2 people), and 13 16 fashion with presentase 0 % (0 people).

Data Interview

Data obtained interview that is divided into two, interviewing three speakers and a petite woman modular fashion. Petite woman interviews is that speakers are the truth often found difficulty in obtaining appropriate size fashion. In addition, speakers have to cut or folded clothes when she found a garment that is too long, to have to spend the money to the mempermak fashion. Of a fashion concluded that the speakers tended to choose pieces fashion looks better in short order, the speakers also noticed a silhouette when selecting clothes look balanced in order that the body.

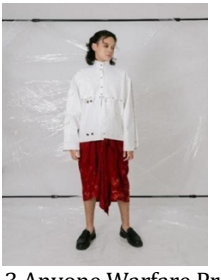


Figure 3 Anyone Warfare Product
Source : Rachel Evelyn Candra “Anyone’s Warfare” 2023

To get modular fashion data, the author interviewed a fashion designer named Rachel evelyn candra with the name of the collection of anyone's warfare who raised the issue of sexual harassment. This dress is a modular jacket that uses thrifting materials and sablon techniques.In the design process. The only thing the source notices is the selection of materials. Mining or connector, and look at the resulting. Sources select rust iron buttons as connectors in each module with the resulting bases and modules can be exchanged for each collection. Like any exchangeable jacket arm and lower jacket module that can be used as a totebag. The use of buttons is also flexible because it can be adjusted to the user's will and look produced better than the use of zippers.

In modular fashion design, of course it has its own challenges. When design needs to be looked at technical fashion or calculate each module in order to produce a different look or even produce a new item from the module. Other than that, need to pay attention to fabric fibers as well as proper button placement. In this design it needs to ensure that the resulting fashion is not only off the tide but each module has its own function.

DISCUSSION

Step of works

1. The production process of analysis related all the data regarding women's petite and modular fashion is then implemented in the development process of fashion design concepts.

2. Brand Identity

Figure 4 Brand Vertelle
Source: Personal Data, 2024

The brand developed by the author is vertelle. It's coming from the word vertellen. It means to tell the story. This brand holds the story / experience of the Petite woman in finding the appropriate dress. This brand puts women's needs ahead of itself and aims to help the petite women in the fashion sector and make the petite women look confident. Market target of the brand. This is a Petite woman with a height of 145 to 160 centimeters., aged 17-27, high middle, student / worker, first of all locals, and have an interest explore look.

3. The theme
   Theme raised is fall ribbon, taken based on trend fashion fall season 2024 that uses the monocrom color of beige and trends expected to rise in 2024. The ambiance created is girly and calm, implemented with romantic feminime fashion style combined with classic elegant. The concept is tailored to the needs of petite women as well as the independent concepts of modulars.

4. Concept

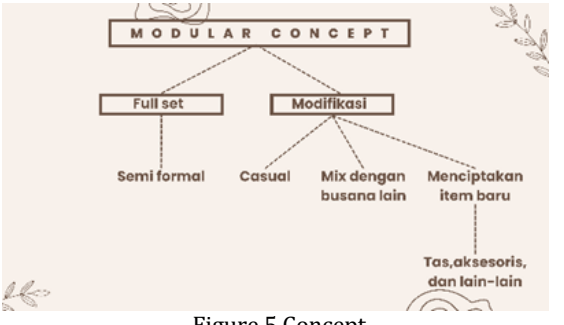


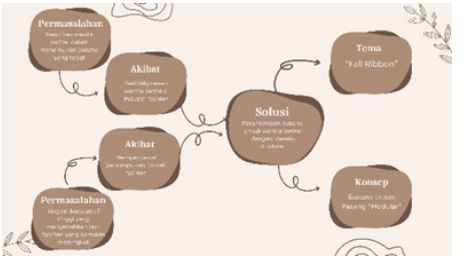
Figure 5 Concept
Source: Personal Data, 2024

The concept of modular fashion that is lifted has two different ways: modular clothes produced when full fashion set and modular fashion are modified. Modular fashion full set generates semi-formal look. For modifications to be casual, with the other clothes, can also create new items like bags, accessories, and another other than modulars, This work uses

the concept of sustainable fashion. Sustainable is slow fashion of multi-wear look, pay attention to quality, and timeless. In its design also considers the impact on the environment and the comforts, that therefore uses a comfortable fabric of natural fibers and can minimize waste.

Figure 6 Sustainable Concept
Source: Personal Data, 2024

5. Mind Maping



Source: personal data processed in 2024

Mind-maping method on this concept used to dig up information from the problem, result, solution, theme, and concept used as reference to the fall design ribbon.

6. Moodboard

Moodboard is a collection of images, color and type of object that can describe ideas as a reference in design design to determine the atmosphere, The color, the impression and theme that supports the concept in this case of fall ribbon.

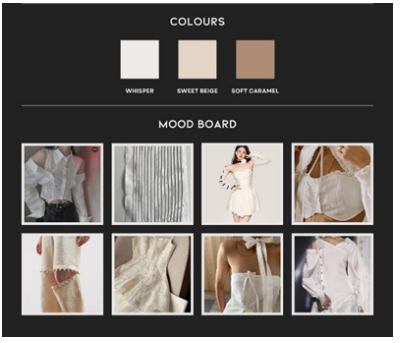


Figure 7 Moodboard
Source: personal data processed in 2024

7. Design

Every design has an arm, the Boss, and subordinates that can be exchanged between designs that can be adapted to the user. In addition, the boss and subordinate can be used to mix and match other fashion. This gives the user a creative space in creating the fashion that she wants.

Figure 8. The Design "Fall Ribbon"
Source: Personal data processed in 2024

a. Arm off
b. Put off the waist up and could be belt
c. Boss can crop output to fashion and may provide another
d. Skirt with the hemisphere that height can be arranged

Figure 9 The Design "Fall Ribbon"
source: personal data processed in 2024

a. Arms off
b. The corset can be removed. And there's an adjust rope on the back
c. The tearable top
d. Pants can be set for shorts and trousers

8. Materials

Figure 10. Materials
source: personal data processed in 2024

The selection of materials in the fall ribbon fashion design is very noted for fashion to last. The fabric used was a natural fiber like cotton fibers, linen, tancel, and bamboo. In each tear-off fashion module, using rust iron buttons as a link.

9. Bussiness & Market

In this digital age, The marketing of petite fashion products with modular design with the name of the fall ribbon collection is done through social media and e-commerce like Tiktok, Instagram, Facebook, shoppe, and the

pedia store. Modular design provides ease for the petite consumers to adjust their clothes to their body proportions in more precision. By utilizing vast social media and e-commerse platforms, vertelle can create an interesting marketing campaign and focus on the right market segment. This strategy allowsvertelle to communicate directly with the audience. Using photos and videos that display modular design variations, and inspires style to potential consumers. Through the innovative combination of designs tailored to the body needs of petite and the power of social media platforms and e-commerce. The marketing of petite fashion products has expanded its coverage and its impact on creating more persona shopping experiences.

CONCLUSION

After research and design process of fall ribbon fashion which has been described in previous chapters, authors may conclude that: from the design process a piece of clothing intended for women petite with modular design, raised from the problem of women's dissatisfaction in the fashion industry and rising fast fashion. The author can pack it into a concept called fall ribbon. This title came from a 2024 combination of fall seasones and ribbon trends packed with a petite woman's custom dress with modular design capable of multi-wear look. Modular concept provides an innovative and flexible solution. Allows women petite to adjust their clothes to higher precision.

This combination also produced a work that had a deep story related to all the women's difficulties in the fashion world. Other than that. Fashion design for women petite with modular design brings revolutions in fashion worlds considering the diversity of body shapes. In order to produce a good piece of clothing and to overcome women's difficulties. Petite women and fast fashion issues, process identification of problems and author references accompanied by various data sources until learning more deeply to find the correct solution. It was then poured into design, so it was created by a piece of clothing that could be the hope of a petite woman.

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LINKING THE PHILOSOPHY OF GOTONG ROYONG TO CONTEMPORARY INDONESIAN PRODUCT DESIGN

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Abstract

This article examines the relationship between Gotong Royong, a traditional Indonesian philosophy of cooperation, and contemporary sustainable product design in Indonesia. From a design research perspective, this paper aims to investigate the potential for integrating Gotong Royong principles into the practices of designing and manufacturing ecologically and socially conscious products. The objective of this paper is to analyse how the reconsideration of traditional concepts of collaboration, shared local resource utilisation, and community-centric approaches can facilitate transformative changes in the world of product consumption. The author examines the potential and challenges of design thinking practices and business models that involve local knowledge and communities, with the aim of resulting in sustainable and regenerative products. Already well-researched social enterprise models of sustainable and regenerative design, such as fair-trade practices and profit reinvestment concepts, are complemented by the Gotong Royong concept. By aligning the principles of Gotong Royong with contemporary design ventures, Indonesian product design practices have the potential to become role models for sustainable, inclusive, and culturally resonant practices, that bridge tradition and innovation in Southeast Asia and internationally. This would contribute to the relevance of design practices for our anthropogenic (future) realities.

Key words: gotong royong, collaborative design, sustainable materials, community-centric manufacturing, regenerative design, design for the anthropocene.

INTRODUCTION

The traditional Indonesian philosophy of Gotong Royong, which emphasises mutual cooperation and community-centric approaches, offers a valuable perspective in the context of contemporary product design studies. This paper explores the potential for integrating the principles of Gotong Royong principles with contemporary sustainable and regenerative design practices, and their capacity to transform the landscape of product design in Indonesia.

The background and motivation of this research are based on the author's observation of the (internationally) increasing need for sustainable and culturally resonant design solutions that address anthropogenic challenges. The term 'Anthropocene' is a widely discussed concept that defines our current geological epoch as being significantly shaped by humanity's impact on Earth's ecosystems. This impact is evidenced by phenomena such as climate change, biodiversity loss, and pollution (Crutzen & Stoermer, 2000). The concept of the Anthropocene emphasises the interconnectivity between human activity and environmental (in)balance.

This discourse gained prominence around the turn of the millennium (Steffen et al., 2007) and, almost two decades later, has become increasingly pertinent as a perspective (Horn & Bergthaller, 2020). In the context of design research, this implies the necessity for discourses about the reevaluation of contemporary design practices and the role of designers in fostering sustainability and resilience. As humanity navigates the Anthropocene, discussions surrounding the anthropogenic impact on the environment increasingly advocate for more inclusive approaches that incorporate both equity and sustainability goals (Leach et al., 2018; Vallance et al., 2011). In this context, the author considers the convergence of traditional manufacturing techniques and community-based approaches with contemporary sustainable design practices to be of significant value. These approaches have the potential to facilitate a more holistic, resilient, and regenerative response to (future) ecological crises.

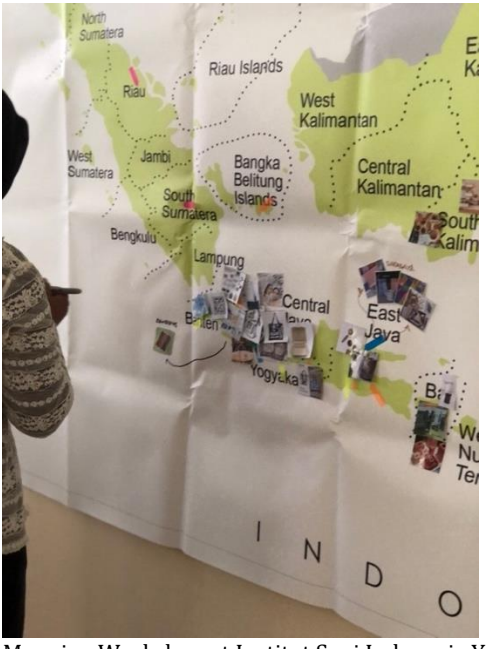

Figure 1. Mapping Workshop at Institut Seni Indonesia Yogyakarta.
Source: Author's own, 2023.

In addition to these widely discussed discourses, the study draws upon the author's first-hand observations of the Indonesian sustainable design scene during her extended research visits to the islands of Java and Bali. During these visits, she engaged with a variety of start-ups and not-for-profit organisations involved in the development of upcycled and/or circular products, as well as regenerative material innovations. Two such enterprises are presented as examples in this text. Moreover, the findings are based on the outcomes of a workshop conducted by the author with product design students at the Institut Seni Indonesia in Yogyakarta in October 2023. The one-day workshop, which was attended by 20 participants, was focused on the collective mapping of sustainable and regenerative design practices and product innovations from Indonesia (see Fig.1).

Recent discourses in various research fields indicate a growing interest in the incorporation of traditional values and local knowledge as a means of fostering regenerative and sustainable development. To illustrate, in the context of geography and social sciences, Berkes (2012) examines the significance of local and indigenous knowledge as a supplement to scientific ecology. The indigenous botanist Kimmerer (2015) presents a detailed account of the resilience and adaptability of plants and animals in response to environmental change. In a more recent contribution, as part of the Africa-focused COP28 Resilience Hub (CDKN, 2023) Sabour reiterates the significance of cultural values in this context, proposing that the acknowledgement of local traditions has the potential to foster more resilient and sustainable environments. The interrelation between sustainable design and local, indigenous knowledge systems, suggests that traditional skills can provide contemporary solutions that are ecologically and socially intelligent, while also preserving cultural identity.

The discourse on this topic has been extensively explored in the fields of architecture and design research since the 1960s and 1970s. In the Global North (where the author of this paper originates from) one of the most discussed theorists was the philosopher and designer Victor Papanek. Papanek promoted the now often (mis-)used saying “All men are designers” (1971) to highlight that utilising wisdom of traditional materials and manufacturing would lead to a more sustainable world. In the field of architectural theory similar approaches gained traction, for example with the discourse around so-called anonymous architecture (Rudofsky, 1964). More recently, the design critique presented by Thackara (2015) further reinforces such perspectives by advocating for a paradigm shift in design that embraces local contexts and wisdom. He argues that such integration is imperative for the creation of environmentally sustainable and culturally relevant solutions.

It is noteworthy that such studies, predominantly conducted by academics from the Global North, frequently utilise observations made within indigenous communities in the

Global South to illustrate the convergence of regeneration, circularity, and social enterprise. This provides a conceptual framework for the design of products that are not only environmentally sustainable but also socially responsible. However, it is important to acknowledge that communities in the Global North have also historically embraced collectiveness, particularly in the context of village life, agriculture, and production. The exploration of such practices is a valuable path for further research.

A critical evaluation of the past decade's design research reveals a gap in applying traditional community knowledge, such as the Indonesian principle of Gotong Royong to contemporary design frameworks. Although the discourse about participation and community-led decision-making is multilayered and well-established (see Sanoff, 2000 for an introductory overview), particularly within the fields of architecture and urban planning, only a few have explicitly linked product design to such concepts. Furthermore, there has been no previous attempt to bridge the gap between sustainable design practices with the philosophy of Gotong Royong.

This gap in the discourse indicates a missed opportunity for international design discourses to enhance sustainability by drawing on established communal philosophies that foster collaboration and resilience. This paper aims to address this gap by examining the potential for aligning the principles of Gotong Royong with contemporary product design practices. In particular, it identifies the impact of local knowledge, local resources, and community engagement as Gotong Royong values as part of two example ventures highlighted as case studies in this paper. The objective of this spotlight analysis is to establish a further synthesis between tradition and innovation, emphasising the potential of these traditional community concepts (which can be found in all parts of the world) as a transformative force in the way we produce and consume.

Mapping Sustainable Design in Indonesia

The central qualitative methodology of this study is a comprehensive mapping of the landscape of the sustainable, regenerative, and circular product design landscape in Indonesia. The author initiated this mapping project in July 2023 and regards the progressive expansion of findings as an ongoing, agile process, continuously enhancing the comprehensive database. The mapped entities which include design ventures, non-governmental organisations that develop product innovations, and other relevant designing and manufacturing enterprises are documented, and analysed from a variety of perspectives. This process serves to establish the fundamental data for a series of studies within the author's research field on sustainable design in Indonesia and Southeast Asia. In this paper, the author considers the integration of the principles of Gotong Royong as a perspective within the mapping results.

The following section delineates the methodology employed in the mapping process.

1. Identification of design practices: During her research visits the author engaged with a number of professional networks located across the islands of Bali and Java. These networks focus on sustainable and regenerative product and material innovations, which enabled the author to become acquainted with a multitude of designers and design practices. Furthermore, she employed a variety of digital resources, including thematic WhatsApp groups, newsletters, and social media platforms such as LinkedIn, to identify a diverse range of individuals and organisations in Indonesia, including young designers, established professionals, start-ups, design firms, non-governmental organisations, and other initiatives. These were collated into a preliminary list of potential subjects for further investigation.
2. Implementation of the identification process in a workshop format: In the course of the workshop conducted at the Institut Seni Indonesia in Yogyakarta the author asked the

participants to identify more sustainable design entities in Indonesia. Following an introductory session to define the scope and objectives of the workshop, the students were tasked with researching two to three examples of such design practices. The author considers this student participation to be a particularly valuable source for her database, given that the participants were all Indonesian citizens, born and raised in a range of locations across the country. The author views this as an important means of diversifying perspectives and sources on the topic, which is essential to avoid any potential research bias. With a total of 20 participants, the number of sustainable entities identified (excluding duplicate entries) was 39. When combined with the author's research, this database represents a data set of over 100 mapping results with ongoing growth.

3. Analysis and evaluation: Following the presentation of a series of potential examples, the author evaluates the entities found, from a range of perspectives and with a variety of research questions: How sustainable is the product according to production processes, and materiality? Where and how is the product sold? Is a long-distance transportation necessary to produce and sell the product? Which of the 17 SDGs (United Nations, 2015) are targeted? How are challenges solved? Does the venture address a circular approach? Does the venture highlight social values for their modes of production and employment mechanisms? These are only a few examples of the evaluation process. The same process of analysis and evaluation was conducted with the participants of the workshop.
4. Geographical mapping and regional analysis: The collated data is incorporated into a geographical map of the sustainable design practices that are in operation across Indonesia. This entails the plotting of the locations of design firms, innovation hubs, and notable design projects intending to identify regional trends and clusters. The author plans to digitise this map for open access and agile development.

5. Case studies: The author employs a selected number of illustrative case studies from the aforementioned database to exemplify specific instances of design practices. The case studies are further enhanced by the inclusion of photographic documentation, both by the author and by the entities responsible for the design in question. In addition, they contain narrative and episodic interviews (Mueller, 2019; Anderson & Kirkpatrick, 2015) with key stakeholders, founders, and other relevant experts.

Mapping is an increasingly prevalent qualitative research method in design and architectural research that emphasises the socio-political contexts of spatial relations (kollektiv orangotango+, 2018). The method entails the creation of maps that not only represent the physical spaces in question but also serve to highlight the relationships, power dynamics, and community narratives that shape those spaces. The author has previously employed this research approach in other projects to gain a deeper understanding of the ways in which environments are experienced and shaped by social interactions. This enables designers and architects to create more inclusive and context-sensitive solutions, particularly in the context of anthropogenic challenges. In design thinking contexts, mapping serves not only as a tool for systematisation, but also for reflection and critical analysis (Mameli, 2021).

The author's objective is to provide an in-depth understanding of the status of current sustainable and regenerative product design practices throughout Indonesia by focusing on the combination of a qualitative mapping approach with selected case studies. Concurrently, it is imperative to address the inherent limitations of this approach. Given the qualitative focus of the study and the narrow scope of its regional and sectoral coverage, it is possible that the full spectrum of product design practices in Indonesia may not be adequately represented. The mapping does not yet include regions with less documented design activities or more remote areas. Consequently, the data represents a snapshot in time and

place. Moreover, it should be noted that the use of self-reported data from surveys and interviews in this kind of methodological approach may introduce potential biases. It is possible that designers and stakeholders may provide responses that reflect ideal practices rather than actual implementations. Furthermore, the author acknowledges the potential for bias, whereby she may be drawn to specific projects and products more than others, which implies a certain degree of 'curation of findings'.

Further research and a continuous mapping intend to address existing gaps in the knowledge base. As the research programme is designed to be agile, a more comprehensive picture of the sustainable design landscape in Indonesia over time. Despite the gaps highlighted, the qualitative mixed-method approach implement for this study, allows a reflection on the potentially unconscious implementation of traditional values, such as Gotong Royong, and their influence on current sustainable and regenerative product design practices in Indonesia.

Relating Gotong Royong Principles to Indonesian Product Design Practices

The traditional practice of Gotong Royong, which emphasises communal cooperation, remains a vital aspect of both rural and urban contexts in Indonesia. Historically rooted in village life, this concept is considered to foster social cohesion and mutual assistance among community members (Simarmata et al., 2020).

In rural areas, the practice of Gotong Royong is exemplified primarily through agricultural cooperation, whereby villagers work together during planting and harvest seasons, sharing labour and resources (Rosyani et al., 2019). In urban contexts, this practice has adapted to meet the challenges of our contemporary world (Slikkerveer, 2019). A multitude of community groups organise initiatives such as neighbourhood clean-ups and emergency response teams to enhance local resilience (see Agenda 21 for Culture (n.d.) and Taufiq (2022)

for recent examples). For instance, during the pandemic caused by the SARS-CoV-2 virus, many urban communities mobilised (re-)connecting in the spirit of Gotong Royong to provide food and medical assistance to vulnerable populations, thereby demonstrating the enduring relevance of this concept (Irasanti et al., 2020). These few examples serve to illustrate the resilience of Gotong Royong as a multilayered and fundamental element of Indonesian culture, for some thinkers even evident in the legacy of Pancasila, and contemporary democratic life in Indonesia in general (Simarmata et al., 2020).

Seeing the relation between contemporary design research and design discourses claiming for the reconsideration of traditional practices of collaboration, circularity, and resource conservation, this study regards Gotong Royong principles as a significant philosophy for sustainable product design practices, not only across Indonesia but also internationally. The author's mapping research approach aims to emphasise that regeneration, circularity, and community-centric values are already incorporated in designing and manufacturing ventures in Indonesia at various levels. This spotlight article will focus on two of the interrelated Gotong Royong principles:

The first principle to be discussed is that of collectivity and inclusivity. By incorporating the input of multiple stakeholders, including designers, artisans, manufacturers, and local communities, at each stage of the product design, production, and manufacturing process, collective needs and preferences are integrated into the final product. Such democratic involvement may manifest in a number of ways. In the design phase, these could take the form of workshops and co-creation laboratories, for example. Moreover, the practice of collectivity necessitates the sustained involvement of community members throughout all phases of product development. This ensures that the products are not only relevant and beneficial to potential consumers but also to all stakeholders involved.

A second principle of Gotong Royong is the utilisation of local resources, both material and immaterial, in the form of the usage and leverage of traditional production techniques and

local materials, as well as, where applicable, the concept of circularity. The importance of local empowerment within circular economies (Geissdoerfer et al., 2017) has been thoroughly discussed in a variety of discourses, with the suggestion that the involvement of community stakeholders in the production process can result in more resilient and adaptive economic and social systems.

The utilisation of local materials and traditional techniques for the purpose of sustainable and regenerative product design represents a significant market within the domain of ecologically and socially conscious consumerism. For Indonesia, this could entail the development of products utilising local and traditional materials, such as bamboo and rattan, as the first highlighted example of this paper shows. Additionally, in the context of understanding products at the end of their lifecycle as new anthropogenic resources, the use of recycled materials, such as plastic waste, could be employed as a truly circular design approach (see second example in the following).

The following section presents two case study examples that illustrate the integration of the described key principles of Gotong Royong in two distinct ventures: Handep and Sungai Design. The two enterprises exhibit considerable differences in terms of their structural organisation, their approach to product development, and the products they create. The author deliberately selected these two ventures to illustrate the diverse manifestations of the Gotong Royong philosophy in contemporary Indonesian product design, encompassing its inherent potential and associated challenges.

Village Wisdom and Craftsmanship – Handep

Handep (n.d.) is an Indonesian sustainable design venture that focuses on a close collaboration with Dayak artisans and farmers. Handep's partnership model is explicitly grounded in the principles of fairness, trust, and mutual respect. As Handep states in their 2022 impact report, "Our weavers and farmers are partners and co-creators in the production process, rather than mere workers." (Handep, 2022, p. 12).

Handep's approach to recognise the status of weavers and farmers as partners and co-creators, rather than anonymous suppliers reflects the company's fostering of a community-oriented approach to village economies. By joining Handep, indigenous partners from the Kalimantan region (Indonesian Borneo) are supposed to benefit from a transparent and equitable framework that includes fair compensation, financial literacy support (from workshops to assistance with opening bank accounts), and the opportunity for village communities to run a profitable and sustainable business with their traditional skills (see Fig. 2 and Fig.3). With their approach Handep, which was awarded the Indonesia Brand Founders of the Year accolade in 2022 (Handep, 2022, p. 3) among other recognitions, is not only dedicated to providing its partners with a regular income, but is also committed to contributing to sustainable environments, forest preservation and the safeguarding of the ancestral weaving skills of Dayak culture. As stated in the organisation's 2022 impact report:

"Craft is a people business, deeply entrenched in community. Raw material is processed by farmers, dyers, weavers, and embellishers, before eventually making its way to end-users. It is also frequently one of the few viable sources of income for Indigenous communities, especially women.

Beyond being a commodity, craft embodies the identity and culture of a community. Craft constitutes a physical manifestation of belief and value, a symbolic visual language. It embodies the relationship between a community and its environment. Craft is about a complex and noble relationship, the passing of skills from generation to generation." (Handep, 2022, p.5)

The exponential growth of the extractive industry in Kalimantan has resulted in a significant increase in deforestation, the displacement of indigenous communities from their traditional territories, a decline in sustainable forest-based products, and the erosion of traditional practices. The

aforementioned issues have resulted in a situation of structural poverty among the Indigenous Dayak community, a phenomenon that is similarly observed in other Indigenous communities across Indonesia and globally.

Since its establishment in 2019, Handep has collaborated with over 350 local indigenous women artisans in seven partner villages situated in Central and West Kalimantan and Pandeglang (Handep, 2022, p. 16). Handep is a highly versatile enterprise comprising a diverse array of projects and programmes. In addition to exhibitions and workshops (see Fig.2), its activities include a variety of collaborations, such as the development of limited editions with Indonesian creatives and entrepreneurs, with the objective of establishing a sustained dialogue between designers based in urban areas and artisans in rural Indonesia.

Figure 2. Handep Training Sessions with Local Artisans.
Source: Handep, 2024.

Figure 3. Local Rattan Weavers for Handep.
Source: Handep, 2024.

Handep's approach to village economics, its transparent business development and community-centred manufacturing modes align closely with the principles of Gotong Royong, which were previously outlined. As a second and very different approach, the author presents an Indonesian design venture that originated with a not-for-profit organisation and commenced river cleaning in Bali in 2020..

Furniture from Upcycled River Plastic – Sungai Design

The Sungai Design product range has been developed using Bali's river plastic and is intended to exemplify the potential of waste materials to be transformed into products. So far this is a small collection of several chairs and benches (see Fig.5). Sungai Design's objective is to upcycle as much river plastic, with the aim of raising funds for river clean-up operations worldwide. The upcycled river plastic derives mainly from plastic bags rescued and collected by Sungai Design's non-profit sister organisation, Sungai Watch. According to Sungai Design (n.d.), each furniture sale contributes to the funding of Sungai Watch's cleanup efforts.

The plastic bags that are used undergo an extensive cleaning process, during which any residual matter from their

previous use is thoroughly removed. Subsequently, the plastic bags are transformed into hard, durable sheets through the processes of shredding and heat-pressing, which serve to form the foundation of the furniture designs. The sheets are then shaped by CNC technology into a series of panels, which form the structural backbone of the finished product. All offcuts occurring during the furniture production are reused to create other products, demonstrating the venture's commitment to a zero- waste approach (Sungai Design, n.d.). Since their foundation in 2023, and according to their website (Sungai Design, n.d.) Sungai Design has upcycled 10,000 kg of plastic bags sourced from its sister organisation, Sungai Watch.

Until today, Sungai Watch is mainly active on the island of Bali, but recently also commenced the organisation of clean-ups on the island of Java. One of the organisation's principal initiatives was the installation of river barriers for capturing the plastic waste before it reaches the ocean. The installation of these barriers serves to reduce pollution and is simultaneously intended to function as a catalyst for community involvement, as a 'visible reminder' to take action against river pollution Sungai Watch attempts to raise a sense of responsibility towards local Balinese and Javanese ecosystems (Sungai Watch, n.d.). Additionally, Sungai Watch claims to implement a variety of educational initiatives in academic institutions and local communities with the objective of fostering comprehension of the environmental challenges posed by plastic pollution and the significance of maintaining clean waterways. Sungai Watch's multifaceted approach includes a community engagement in the form of the possibility of joining their river clean-ups and related community events (see Fig.4), with the objective of raising awareness and mobilising local action.

Sungai Watch states that 80% of the ocean's plastic pollution originates from rivers. So far, the non-profit organisation has installed 300 floating barriers throughout Indonesia's rivers and collected over 2,300,000 kg of plastic, 36% of which is plastic bags (Sungai Watch, n.d.).

Figure 4. Gardening Gotong Royong with Sungai Watch and Astungkara Ways.
Source: author's own, 2024.

Handep as well as Sungai Design demonstrate how diverse contemporary Indonesian attempts are to develop products that are simultaneously functional and culturally meaningful, while also benefiting local environments and communities. The Handep enterprise is specifically facilitating the integration of communities with a strong traditional presence, such as those in rural Java and Bali, where the principles of Gotong Royong are still observed and integrated into product design practices. By establishing a connection between the local and the global, (international) designers are presented with the opportunity to engage with and utilise local craftsmanship and wisdom, employing traditional techniques and resources in the creation of contemporary designs.

The approach adopted by Sungai Designs places greater emphasis on the utilisation of the Gotong Royong principle of community, as evidenced by the numerous river clean-ups conducted together with volunteers by their sister venture Sungai Watch, and their attempt to further develop upcycling technology for the creation of design products. Both initiatives collectively illustrate the potential of Gotong Royong in sustainable ecologically and socially conscious product design.

Discussion

The author's findings suggest that the Gotong Royong principles have the potential to facilitate interconnectivity between Indonesian local wisdom and traditional community presence, such as found in rural Java and Bali, and innovators, designers, and entrepreneurs. Designers in this context engage with local communities, utilise traditional techniques and prioritise resource sharing. This not only upholds the essence of Gotong Royong but also fosters a connection between the community and the design process, thereby facilitating the creation of culturally resonant and sustainable products.

Potential (wealthy) consumers of such socially and ecologically conscious products are typically located in urban areas, too. This observation derives from the exceptionally high population density of Java and Bali, where urban centres like Jakarta, Badung, Surabaya, and Yogyakarta are home to a significant proportion of Indonesia's economic activity and serve as hubs for tertiary education and innovation (UNFPA, 2020). Bali, in particular, occupies a distinctive position as Indonesia's primary tourist destination, attracting millions of visitors on an annual basis (Badan Pusat Statistik, 2024) and with this development also fostering a market for sustainable, artisanal and design products.

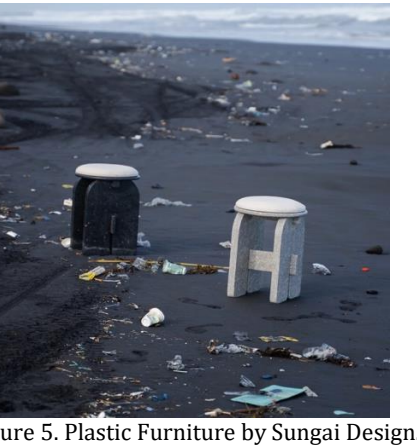

Figure 5. Plastic Furniture by Sungai Design.
Source: Sungai Design, 2024.

This issue serves to highlight the significant economic disparities that exist and the inherent difficulty of making sustainable lifestyles a feasible option for a larger proportion of the population. Those engaged in the field of design in the context of the Anthropocene epoch are confronted with a series of pivotal inquiries. The question thus arises as to how such social enterprise principles might be integrated into large-scale industrial design, rather than remaining the preserve of individual brands catering to elite consumers. What designs, what production processes and profit reinvestments would be necessary?

In sectors such as handicrafts and artisanal products, traditional values are often more seamlessly integrated, reflecting a reliance on local knowledge and community collaboration. Future enterprises will have to find a way to scale their business-models in order to broaden their impact.

Conclusion

This paper provides a spotlight analysis of how the traditional philosophy of Gotong Royong of cooperation, participation and local resource utilisation (in the form of raw materials, manufacturing techniques and local traditions) can be visible in contemporary Indonesian sustainable product design practices. The two exemplary design ventures portrayed in this paper underline the relevance of such Gotong Royong principles in contemporary sustainable and regenerative design practices. The design enterprises depicted show the varying levels of cooperation, snd local resource utilisation across different impact modes and product design solutions, highlighting both opportunities and challenges in aligning traditional values with contemporary design and consumerism.

Despite the challenge of scalability yet unsolved, Indonesian designers and designing enterprises have the opportunity to pioneer a design paradigm that is both innovative and deeply rooted in Indonesian cultural heritage. The interlinkage of traditional social ecologically conscious

values like the ones embodied in the Gotong Royong principle with sustainable and regenerative design practices, offers valuable lessons for global sustainable design practices.

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VISUAL TRANSFORMATION: WUKU SINTA BATIK MOTIF AND ITS IMPLEMENTATION IN THE CREATIVE INDUSTRY

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Abstract

Sinta is a female character in Wayang, found in Serat Pawukon, which became the idea behind the development of batik motifs. The batik motifs initiated by Serat Pawukon have yet to be utilized in the context of the creative industry. The problem raised in this study is how the Wuku Sinta batik motif can be adapted and integrated into creative industry products to increase economic value and cultural appeal. This study aims to identify the Wuku Sinta batik motif that can be adapted to the creative industry. This study uses a qualitative descriptive method. The study results indicate that the Wuku Sinta batik motif can be well adapted to various creative industry products without losing its original cultural value. This finding emphasizes the importance of collaboration between traditional batik artisans and designers to create innovative products with high selling value. This study concludes that the visual transformation of the Wuku Sinta batik motif has excellent potential to be developed in the creative industry, making a significant contribution to cultural preservation and increasing the creative economy in Indonesia.

Key words: batik motifs, creative industry, visual transformation, wuku sinta batik

INTRODUCTION

The calendar we use today has a long history. Its existence became important because it gave humans a clear time frame to know the day, month, and year. (Kumaar, 2022) This is

important because all personal and social activities are based on the concept of time. Calendars help determine when weekdays, holidays, or significant events such as weddings, births, religious celebrations, and more are present. With a calendar, humans will retain their orientation about when something should be done or when a significant event occurs. Philosophically, the calendar connects humans with the universe because there is an eclipse that refers to the movement of the sun, moon, and stars. (Sweatman, 2024)

In the global era, this is called the zodiac. This makes some people feel that there is a connection between nature and the environment and that their lives are in harmony with cosmic movements. In Javanese society, this seems closely attached to daily life; some still believe in good and bad days, so choosing essential days in their lives becomes a marker that must be calculated with the concept of time. Their concept of time is called Pawukon. As an agrarian society, the Javanese use this calendar to determine the time to plant, harvest rice in the rice fields, and perform the agricultural rituals they believe in. (Restinaningsih et al., 2016; Sulaksono, 2019) The compatibility between natural cycles and human activities is considered important to maintain cosmic harmony and Harvest success. In addition, Pawukon also functions as a social and cultural control tool. Pawukon can strengthen the bond of friendship through joint activities with the timing set together by using this calendar. For example, the Javanese people organised the earth alms ritual activities based on Pawukon's calculations. This increases their spirituality and the community's togetherness in respecting their ancestors and protecting the environment.

Pawukon has a unique cycle consisting of 210 days divided into 30 weeks. Each week in Pawukon lasts seven days and has a deep spiritual and symbolic meaning. (Budi, 2016; Primasasti, 2022) One of them is the first Sunday in Pawukon, which is called Sinta. This week is good for starting something new, such as a job or project. Many people choose the days of the Sinta week to plan important events because they are believed to bring good luck. (n.n, 2022; Primasasti, 2022; Wildan, 2016)

Who is Sinta?

Sinta is one of the crucial figures in the story of Ramayana, which is part of the cultural heritage and the art of puppetry in Java. In the Ramayana epic, Sinta is the wife of Rama, a noble hero and an incarnation of Lord Vishnu. The story of Sinta and Rama is widely known throughout the archipelago, especially in Java, because of its values of loyalty, sacrifice, and morality. In puppetry (Hariyanto, 2023; Thomas & Kahija, 2019; Wiwana & Yudarta, 2020), Sinta is described as a loyal, patient, and loving woman.

One of the most famous parts of his story is when he is kidnapped by Rahwana, the giant king of Alengka, who is captivated by his beauty. Sinta remained loyal to Rama despite being in Ravana's captivity for many years. His loyalty was tested many times by Ravana, who sought to influence him, and by Rama, who doubted his holiness after he was released. However, Sinta steadfastly maintained her integrity and honour and eventually proved her purity through a test of fire, which came to be known as *Agni Pariksha.* (Hariyanto, 2023; Wiwana & Yudarta, 2020)

In the world of Javanese puppetry, Sinta is a symbol of women's sincere devotion, sacrifice, and inner strength. Sinta's character reflects women's idealism in Javanese culture, where loyalty and honour are the central values that must be maintained in marriage and family life. Sinta also teaches the importance of patience in facing life's trials and how moral strength can overcome obstacles.

Sinta Character in Pawukon

The name Sinta, mentioned in the first week of the Pawukon calendar, is inseparable from the symbolism of Sinta's character. As the first week in Pawukon, Sinta's week is considered a new beginning, full of hope and potential. The name Sinta was chosen to represent this early time because of its nature, which was full of holiness, sacrifice, and virtue and considered ideal values for starting something new. The placement of Sinta in the first week of Pawukon also reflects the Javanese philosophy that pays great attention to balance and harmony between human life and nature.

At the beginning of time, the Javanese calendar system had significant momentum to create spiritual and emotional balance. Sinta Sunday is a great time to pray, meditate, and start everything with good intentions and strong determination. With her loyalty to Rama and steadfastness in maintaining honour, Sinta is considered an ideal example for anyone who wants to start a new life or venture with a solid foundation and high morals. In addition, in Javanese tradition, the names of the weeks in Pawukon are often taken from symbols or essential figures who are considered to have spiritual or moral power. The name Sinta was chosen because she was not only known as an essential figure in mythology but also as a representation of the highest human virtues—loyalty, chastity, and sacrifice.

The Javanese people respect these values and consider Sinta week an ideal time to start a new life journey. The Sinta Week in Pawukon is not just a name but also a representation of a philosophy of life that values early purity, moral constancy, and harmony between humans and nature. Through Sinta's symbolism, the Javanese people are invited to start every life journey with good intentions, patience, and sincerity to obtain a harmonious and blessed life.

Some studies that have been conducted

Mutiara Putri Dhamastuty (2018) examines the symbol of the image of Pawukon, which focuses on the history and myth of Watugunung. The approach used uses the interaction of analysis with qualitative descriptive results. The theory that is the reference is Susanne K. Langer's theory of symbols, which includes discursive symbols and representational symbols. The results of his research explain that the time system in Pawukon is still widely used by the Javanese people in the form of detailed calculations because it is used in essential activities in their lives.

The calculation in Pawukon is used as a benchmark for the good in life: be careful in behaving and be vigilant. (Dhamastuty & Adisukma, 2018) Another researcher, Adisukma, stated more deeply that the images contained in Pawukon have meanings and are a system of signs in Javanese culture. The problem that will be studied is how to interpret the symbolic value of the

Javanese Pawukon image according to the Hermeneutical study. His research focuses on efforts to preserve the traditional value of Javanese Pawukon so that it can be understood by Javanese people again. As a result, Javanese people re-get to know the cosmic realm, become part of nature, and understand that they are also artists from Eastern culture. (Adisukma, 2018)

The two studies have in common that the object of their research is Pawukon; what distinguishes them is how they dissect their research results with different methods. These two studies have not yet utilized the results of their research into products that can be used in daily life and can improve the economy in the creative industry. The Research team carried out research on the use of art illumination in ancient manuscripts originating from Karataon Ngayogyakarta Hadiningrat into batik motifs. However, it has yet to be implemented in creative industry products. This research develops artistic illumination into batik motifs. The problem in this study reveals the creative process in the visual transfer from ancient manuscripts to batik motifs. The goal is to develop the idea of creating batik motifs from the illumination of ancient manuscript art.

The method used is a qualitative descriptive method. As a result, ancient manuscripts have succeeded in creating a variety of batik motifs that the public can use and support cultural preservation, as well as spreading the historical value contained in the batik motif. (Pandanwangi, Alya, et al., 2023) Based on the research that has been carried out, there is a difference in the acquisition of results focused on developing products initiated from Pawukon serat. This research has the opportunity to produce novelty in the form of creative industry products from the findings of this research. Referring to the character of Sinta who has many specialties, his visual form is widely adopted for various products for the benefit of many things, especially those that indicate the archipelago.

This is what is thought in the creative process of creating batik motifs that are carried into the creative industry. So the The problem carried out in this study is how the visual form of Sinta initiated from Pawukon can be implemented into products in the creative industry. The purpose of this study is to

implement the visualization of Pawukon serat into creative industry products. This visualization is essential to understand how the dating system is translated into a visual form that is easy to understand and use by the public. This involves making a visual representation into a batik motif and implementing it into the product. This product representation can help preserve and disseminate traditional knowledge and allow the younger generation to more easily understand and appreciate the archipelago's cultural heritage.

RESEARCH METHODS

The field data obtained are the images contained in the Pawukon serat, so the research method that is considered the most appropriate is qualitative descriptive with a narrative approach (Creswell, 2014; Ekowati et al., 2018; Taylor et al., 2016). The stages of the research method are carried out by searching for field data and literature studies. The stages are:

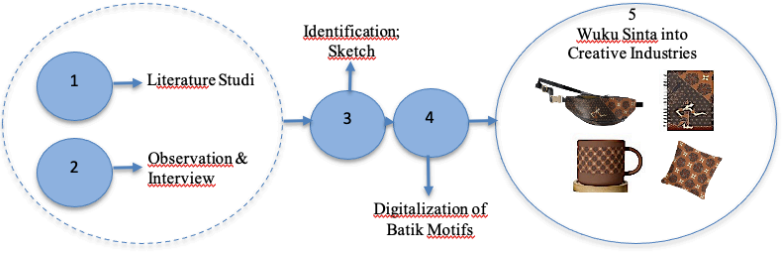

Figure 1. Stages to the Creative Industry
Source: Research Team. 2024

Based on the figure above, the research was carried out through five stages. The first stage is to conduct a literature study, a data search carried out through data from reference books, journals, papers and the internet to support the necessary information (Apin et al., 2023; Pandanwangi, Alya et al., 2023); the second stage is to make observations for field acquisition to the Radya Pustaka Surakarta museum, the images contained in each wuku in the calendar and interviews with informants. During the observation, the researcher recorded and documented data. (Darmayanti et al., 2023; Pandanwangi et al., 2023) The third stage is to identify images and make black-

and-white sketches. The identified images are grouped by type, which can be representative to be implemented into batik motifs. The fourth stage of the researcher creates the Wuku Sinta motif; the process starts with sketching and digitization, and the fifth stage is the implementation of the product in the form of product digitization.

RESULT

Data shows that manuscripts are artefacts in a handwritten form that explain various information about social life, politics, economic conditions, religion, and thoughts about the past presented in the language of the time and literature. The written thought was historical, didactic and religious (Marrison, 2002; Rachman, 2017; Sukaesih et al., 2016). Based on field data, manuscripts in the past were made by poets who were in the palace environment or made directly by Gusti Kanjeng from the palace. Field data in the form of Javanese manuscripts, namely Pawukon Serat. This manuscript contains many pictures of puppet characters made on paper; each image uses good coloured ink. The images are still in good condition, even when the access team cannot touch them. The images that complement the Pawukon serat are sorted according to wuku. There are 30 wuku contained in Pawukon serat. Furthermore, the data was identified, and Wuku Sinta was determined. The choice of Wuku Sinta, because it starts from 30 wuku. The visual form of Sinta's work is.

Table 1 Transvisual Forms of Wuku Sinta

Transvisual Wuku Sinta	
	

	 
Digital Sketch of Wuku Sinta Motif	

Table 2. Implementation into Creative Industry Products

Figure 2. Batik digital wuku Sinta
Source: Research Team. 2024

DISCUSSION

Batik "Pagi-Sore" that is the *point of interest* is Sinta, so it is placed on the left because it has a motif in the background that tends to be delicate; the regular repetition of both the trusted and check motifs at the bottom is very opposite to the figure of Sinta which tends to be more dynamic.

The dark brown colour used in the background contrasts the skin colour, shirt colour and motifs on the dodo so that Sinta looks prominent. However, on the right is a white flower with regular repetition, which does not make it more dominant than Sinta. Sinta is depicted as looking on the side from the face and legs. In contrast, the chest is depicted as a front so that the whole can be categorized in various appearances. It looks distinctive and is depicted from head to toe, according to the traditional depiction.

A shady tree with small leaves looks disguised by the trusted motif; although the flowers are reddish-brown (burn number), the tree, along with its trunk, as well as two crows on the left and right, can fill the space on the right so that it becomes a unit. The black crow is seen looking up, the legs are looking at the side, and the beak and the eyes are looking at the side; this depiction can be said to be various. The crow has the meaning of being able to watch and know what will happen, so the crow is placed on a tree and enlarged because it is considered necessary; so is Sinta enlarged so that it is almost three-quarters of the tree's height.

The motif on the right is depicted as more significant at a greater distance from each other, so the correct part looks more empty. However, in the background, there is a point around the wheel circle of dark brown, the same colour as the outer part of the wheel circle and reddish brown on the inner wheel circle, as well as a yellowish brown colour on the background colour. The left and right parts have a contrasting composition.

In the composition of batik works, Sinta has a vital role, has a strong character, and is very arrogant and dexterous. However, it has weaknesses like humans in general, like being shy, so it is covered with arrogance and easily bored because it is intelligent and dexterous. It also likes to be negligent because it makes the work easier. In this batik work, Sinta is depicted in a commanding position, one of which is a crow to watch over upcoming events. The entire composition in this batik implies the character of Sinta.

Implementation into Creative Industry Products

The batik motifs that have been made in digitization are then implemented into several products that are in great demand among young people, such as mugs, waist bags, chair cushions, and book covers. These products open up opportunities for innovation that combines cultural heritage with the needs of the modern market. In this creative process, it is important to consider various design elements including unity, repetition, balance, proportion, and product material selection, so that the final result is not only aesthetic but also

functional. Some of the products resulting from the implementation of batik motifs can be seen in table 3.

Table 3. Products Initiated from Wuku Sinta Batik Motifs

			
The batik motif on the front of the waist bag between the main motif and the supporting design elements creates a harmonious and compositional look asimetris. The placement of the motif seems balanced between the left and the right. The material used is thin leather, so it is comfortable for users to wear because it follows a circular body shape.	Batik motifs that come from the background of wuku sinta batik. The pattern arrangement is repeated to fill the surface of the pillowcase used for the seat back, giving a rhythmic and attractive impression. The combination of colors with brownish tones can create a sense of warmth in the space. The material used is primisima cotton so it is comfortable to wear	The batik motif carried from the background of wuku sinta batik, has flexibility and flexibility when placed on a curved plane. The unity between the batik pattern and the shape of the product has unity in the way the batik motif is made in a circle in harmony with the shape of the round product, thus creating an elegant appearance. The material used is ceramic.	Batik motifs can also be implemented as diary book covers. The main object of Sinta is the vocal point in the placement of the main object complete with trees and birds. At the top of the background object, the fabric is carried by occupying one-third of the surface of the cover of this book. The material used as the book cover is thick cardboard and coated with batik motifs

Table 3 above shows the success in placing batik motifs into various selected products. In detail, what needs to be considered when placing objects in the form of batik motifs on Various products are the unity of design principles that must be considered, such as balance, proportionality, rhythm, and proportion. This is to realize a harmonious unity. Furthermore, the pattern of the batik motif that is repeated (repetition) produces a flowing rhythm. Loops have a fixed shape, while the colour or size is different. So, the resulting rhythm is repetitive and fills the plane's surface. The Principle of Balance determines the products to be chosen. Balance in a composition gives the user a calm and exciting feeling.

Proportion is another key design principle that deserves special attention in product design. Products that gain popularity on social media often overlook the importance of proportion. A well-designed product structure takes into

account the proportion between its various parts, influencing the overall aesthetics and structure of the product.

The materials used in product manufacturing also play an essential role in determining the final result of a product. For example, mugs made of ceramics are made by highlighting brown waist bags made of soft animal skin, and then batik motifs are implemented on top of the leather. The proper selection of materials ensures that batik motifs look beautiful and functional in daily use.

CONCLUSION

The idea carried from ancient manuscripts to enter the creative industry has many opportunities that artists, designers and the wider community can create. Ancient manuscripts are national assets that can continue to be developed through the development of batik motifs and implemented into various products in the creative industry. The findings in this study are products from ancient manuscripts, and even though they are modern, they contain past thoughts that have aesthetic, functional, and historical value. Products that can be marketed in the future can help preserve culture and transfer knowledge to the broader community.

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