APPLYING 3D PRINTING TECHNOLOGIES ON RECONTEXTUALIZING THE REBAB MELAYU AS A CONTEMPORARY MUSICAL INSTRUMENT

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by

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‘In the name of Allah the most beneficent and most merciful’

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LIST OF TERMINOLOGY

3D Printing	A process of making three dimensional solid objects from a digital file.
Rebab Melayu	A traditional musical instrument of the Malay people.
Aesthetic Impression	This term refers to the overall visual, tactile, and sensory reaction an individual has upon encountering a product or piece of art. It includes responses to elements such as color, shape, texture, and form. The aesthetic impression often significantly impacts user perception and acceptance, playing a critical role in product design and art appreciation.
Semantic Interpretation	The deeper meaning or context behind a product which goes beyond its functional properties and taps into the cultural symbolism and socio-cultural space.
Symbolic Association	Abstract meaning or idea implied or represented by a product or piece of art beyond its physical properties. These associations often stem from cultural, historical, or personal contexts and significantly influence the way a product or piece is perceived and understood. In product design and art, symbolic associations can communicate deeper layers of meaning and engage audiences on a more profound level.
Product Design	The process of creating a new product to be sold by a business or enterprise.
Cultural Significance	The importance of a place or object for past, present or future generations due to its archaeological, historical, scientific, or social importance.
Cultural Heritage	The legacy of physical artifacts and intangible attributes inherited from past generations, maintained in the present and bestowed for the benefit of future generations.
Innovation	The act of introducing something new or different.
Juxtaposition	The placing of two elements side by side, often with contrasting effect
Functionality	The quality of being suited to serve a purpose well; practicality.
Tradition	A long-established custom or belief that has been passed on from one generation to another.

Fusion	The process or result of joining two or more things together to form a single entity.

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MENGAPLIKASIKAN TEKNOLOGI PERCETAKAN 3D UNTUK PENGKONTEKSUALAN SEMULA REBAB MELAYU SEBAGAI ALAT MUZIK KONTEMPORARI

ABSTRAK

Penyelidikan PhD ini mengkaji transformasi dalam mentakrifkan semula alat muzik tradisional Rebab Melayu, sebuah alat muzik tradisional Malaysia yang ikonik, dengan menggunakan teknologi percetakan 3D dalam bidang Rekabentuk Produk. Meskipun penggunaan Rebab Melayu digunakan secara meluas dalam persembahan Makyong dan Main Puteri, namun kepentingan alat muzik ini dilihat menghadapi kemerosotan penggunaanya disebabkan oleh cabaran modenisasi serta kekurangan sumber pembuatan bahan akibat kekangan alam sekitar. Kajian ini secara kritis mengkaji kebolehgunaan dan kepentingan penggunaan teknologi percetakan 3D untuk menghasilkan semula Rebab Melayu berdasarkan nilai cabaran, kelebihan dan kebolehannya. Metodologi penyelidikan yang digunakan merangkumi mengenal pasti ciri-ciri Rebab Melayu tradisional, serta perlaksanaan teknologi pencetakan 3D untuk menghasilkan rekaan Rebab Melayu kontemporari. Selain itu, pengujian empirik dilakukan melalui dokumentasi secara video tentang proses penghasilan dan juga persembahan yang melibatkan alat muzik Rebab Melayu 3D, serta analisis menyeluruh terhadap respons penonton semasa persembahan. Kajian ini juga mengggunakan kaedah amalan dan juga kualitatif dimana temu bual separa berstruktur serta analisis tematik digunakan bagi mendapatkan pandangan yang mendalam. Selain itu, kajian ini juga memberi tumpuan kepada potensi perkembangan teknologi pencetakan 3D dalam mereka

bentuk produk, terutamanya dalam mentaksirkan semula kraf tradisional dan alat muzik, berdasarkan pandangan profesional serta persepsi penonton dalam merungkai kesan estetika, interpretasi semantik, dan hubungan simbolik dalam penghasilan Rebab Melayu 3D. Teras kepada penyelidikan ini adalah untuk merungkai hubungan antara tradisi dan inovasi dengan menekankan keseimbangan dalam melindungi warisan budaya disamping memanfaatkan teknologi moden. Justeru itu, pemahaman yang lebih mendalam dalam Rekabentuk Produk dapat dilihat dengan jelas melalui harmonisasi estetika, kebolehgunaan, dan simbolisme budaya melalui penerimaan sesuatu produk. Berdasarkan dapatan kajian, tesis ini mencadangkan kepentingan dalam mengimbangi kompleksiti pendekatan inovasi dalam reka bentuk serta menghormati tradisi. Hal ini kerana pentingnya memupuk kerjasama antara pengamal tradisional dan pereka reka bentuk moden termasukalah menggalakkan dialog terbuka di kalangan pihak berkepentingan, serta mewujudkan program pendidikan yang menggabungkan seni tradisional dan teknologi moden. Secara keseluruhannya, ia bertujuan untuk meletakkan asas bagi kemajuan masa depan, memperkaya perbincangan dan amalan di antara tradisi, inovasi, seni, budaya, reka bentuk, dan juga teknologi.

APPLYING 3D PRINTING TECHNOLOGIES ON RECONTEXTUALIZING THE REBAB MELAYU AS A CONTEMPORARY MUSICAL INSTRUMENT

ABSTRACT

This doctoral thesis delves into the transformative exploration of redefining the Rebab Melayu, an iconic Malaysian musical instrument, by harnessing the innovative potential of 3D printing technology within the domain of product design. Amid its prevalent use in Makyong and Main Puteri performances, the Rebab Melayu confronts diminishing relevance in contemporary times due to challenges posed by modernization and scarcity of traditional materials, triggering environmental constraints. This study critically examines the viability and implications of employing 3D printing technology to replicate and potentially revitalize the Rebab Melayu, comprehensively evaluating its challenges, merits, and feasibility. The research methodology employs a multifaceted approach encompassing the identification of traditional Rebab Melayu characteristics, the implementation of 3D printing technology for crafting a contemporary instrument, empirical testing through video documentation of the manufacturing process and instrument performance, and a thorough analysis of audience responses during a contemporary music performance. Leveraging a practice-based methodology and qualitative approach, the study conducts semi-structured interviews and thematic analysis to extract nuanced insights. Highlighting the burgeoning potential of 3D printing in product design, particularly in reimagining traditional crafts and musical instruments, the thesis navigates professionals' insights and audience perceptions to unravel intricate dimensions of aesthetic impressions, semantic interpretations, and symbolic associations

elicited by the 3D-printed Rebab Melayu. Central to the thesis is a deep exploration of the intricate intersection between tradition and innovation, emphasizing the delicate equilibrium required to honour and safeguard cultural heritage while harnessing the expansive creative possibilities offered by modern technology. The thesis advocates for a nuanced understanding of product design, elucidating how the harmonization of aesthetics, functionality, and cultural symbolism shapes the essence and reception of a product. Drawing upon the empirical findings, the thesis presents actionable recommendations aimed at navigating complexities, advocating for a balanced design approach that respects tradition while embracing innovation. These recommendations underscore the importance of fostering collaboration between traditional craftsmen and modern designers, encouraging open dialogues among stakeholders, and creating educational programs that fuse traditional arts with modern technology. Ultimately, these propositions aim to lay the foundation for future advancements, enriching discourse and practice at the intersection of tradition, innovation, art, culture, design, and technology.

CHAPTER 1

INTRODUCTION

1.0 Introduction

Chapter 1 establishes the research foundation on the Rebab Melayu by identifying key problems and forming research objectives and questions. It discusses the Rebab's history, structure, cultural significance, and its interaction with modern technology such as 3D printing. The chapter also sets the study's scope and limitations, guiding a focused approach towards a defined target group. Crucial aspects like study samples and location selection are detailed. The chapter concludes by emphasising the study's potential impact on future generations and its role in the preservation and progression of the Rebab Melayu.

1.1 Background study

Innovation in design, characterised by the embodiment of creative ideas into novel products, services, or methodologies, enhances the interaction between users and designs (Norman, 2013). Shifting from a largely aesthetic focus, contemporary design integrates usability, functionality, and a human-centric approach. This transition caters to the evolving global market, various challenges, technological progress, and changing customer expectations (Kolko, 2015). Meanwhile, traditional design often prioritises style over substance, typically neglecting user needs. Conversely, contemporary design promotes human-centric principles, prioritising usability and functionality (Norman, 2013; Brown, 2009). Thus, factors such as user focus, technological integration, interdisciplinary collaboration, iterative prototyping, and sustainability considerations

help shape modern design innovation (Johansson-Sköldberg, 2013; Cross, 2011; Lidwell, Holden, & Butler, 2010).

A prime example of design innovation is 3D printing or additive manufacturing, which transforms product conception and distribution (Berman, 2012). This advancement enables rapid prototyping and intricate form creation, previously impossible with traditional methods (Lipson & Kurman, 2013). Moreover, 3D printing supports mass customization, allowing products to be personalised to individual preferences and needs (Berman, 2012) in which this level of customization has revolutionised industries such as healthcare, where prosthetics and medical devices can now be tailored specifically to each patient (Lipson & Kurman, 2013). Additionally, 3D printing has the potential to reduce waste and environmental impact by only producing what is needed, minimising excess inventory and transportation (Berman, 2012) as well as cost-effectively (Rayna & Striukova, 2016). Thus, with uses across architecture, product design, fashion, and healthcare, 3D printing's impact is vast and transformative, heralding a new era in the design landscape (Birtchnell & Urry, 2013; Ventola, 2014).

As 3D printing innovation continues to break barriers, its application in the production of traditional instruments is gaining momentum. With its renowned ability to replicate intricate designs, 3D printing provides a lucrative alternative to conventional methods of music instrument creation. The music industry is one prime example of a sector significantly influenced by this continual evolution of technology (Birtchnell & Urry, 2013). The realm of musical instruments, in particular, has witnessed ground-breaking changes due to the advent and proliferation of 3D printing technology (Gibson, Rosen, & Stucker, 2014). The potential to manufacture precise and customizable musical

instruments has become a possibility with 3D printing (Berman, 2012). Traditional methods often require masterful craftsmanship and prolonged hours of detailed work to create just one instrument (Ventola, 2014). However, with 3D printing, intricate instruments can be created with a level of precision difficult to achieve by hand, allowing for the fine-tuning of elements like size, shape, and hollow spaces within the structures (Lipson & Kurman, 2013). Hence, this has encouraged innovation, enabling the development of uniquely designed instruments with ease (Birtchnell & Urry, 2013).

As the rapid evolution of technology is significantly shaping various aspects of our society, including the field of arts and music, modern innovation, driven by progress, is constantly seeking ways to merge with traditional practices, providing opportunities for transformation and evolution. This fusion encourages cultural heritage preservation while at the same time propelling it into contemporary relevance. Particularly in the production of traditional musical instruments, an exciting synthesis of heritage and innovation is on the horizon, providing a wealth of opportunities for exploration and development. One realm ripe for such study lies in the use of 3D printing technology in crafting traditional musical instruments, such as the Rebab Melayu, an instrument deeply rooted in Malaysia's cultural identity.

Rebab Melayu, a vibrant symbol of Malaysia's musical heritage, has long been a core element of local traditional music. Rebab Melayu is a musical instrument that has been used in various Malay traditional performances such as Makyong, Main Puteri, Tarik Selampit, and Wayang Melayu located on the east coast of Malaysia. This instrument exemplifies the rich past of musical exploration and adaptation, being initially brought to Pattani from Persia and later modified using local materials and methods to better resonate

with the local people. Rebab Melayu instrument today represents the fruit of continuous adaptive innovation that has transpired over generations, allowing it to blend seamlessly with the ever-changing music scenes on Malaysia's east coast (Ghouse, N. M., 1989; Nik Mustapha, N. M. S., 1995; Jusoh, C. M., & Bidin, M. O., 2018).

However, despite its cultural significance, the process of creating and refining the Rebab Melayu rarely incorporates contemporary innovation or technological advancements. Historically, the crafting of the Rebab Melayu relied heavily on the skills of its artisan, who painstakingly carved the instrument from wood, utilising techniques handed down through generations. Thus, this research will navigate this unexplored path, aiming to shed new light on the opportunities and challenges inherent in the application of innovative technologies such as 3D printing to the making of the Rebab Melayu.

1.2 Definition and Terms

This study delves into several keywords that are pivotal to the research, namely 3D printing technologies, Rebab Melayu instruments and contemporary musical instruments. Within the framework of Chapter One, this section aims to present a concise yet comprehensive explanation of these terms and their significance. By exploring these key terms in-depth, we can establish a solid foundation of understanding regarding their relevance to the study at hand. This exploration will shed light on the contextual framework of the study and elucidate the specific ways in which these terms are employed within their respective contexts.

1.2.1 3D Printing Technology

Since the onset of the first Industrial Revolution, also known as Industrial Revolution 1.0, production and manufacturing processes have undergone significant transformations in their operations (Hobsbawm, 1962). Among the innovative technologies introduced during this period, Rapid Prototyping (RP) emerged as a promising tool in manufacturing (Berman, B., 2012; Dudek, P., 2013; Jabar, Q. A., 2015). The technology's primary appeal lies in its capability to swiftly convert an idea into a prototype, eliminating the need for comprehensive pre-production tooling. RP encompasses two main manufacturing strategies, namely Additive Manufacturing (AM) and Subtractive Manufacturing (SM). Predominantly, AM involves layering materials to create a prototype using a heated extrusion process, while SM focuses on eliminating unwanted elements from the existing material structure, done by conventional deburring methods or digital machinery like Computer Numerical Control (CNC) machines (Ashby & Johnson, 2010).

In the present era, AM, specifically 3D printing, has become more prevalent due to the patent expiration, which reduced the cost substantially, opening the technology to manufacturers, including amateurs (Shahrubudin, et al., 2021). The technology has found applications across multiple domains, including manufacturing, healthcare, and dentistry, with Fused Deposition Modelling (FDM) being the most preferred technique (Shahrubudin, et al., 2021). Moreover, 3D printing has simplified the component generation process into a structured three-step process, "Design, Analysis, and Printing", resulting in a high-grade final product (Shivraj, et al., 2021).

That being said, the design phase can be executed using Computer-Aided Design (CAD) software like Rhinoceros 3D, which is an improvement from traditional manufacturing methods, which involve ideation through 2D and 3D sketches or mock-ups (Shivraj, et al., 2021). Hence, the recent CAD software offerings, including Rhinoceros 3D, Solidworks, and Autodesk Alias, among others, better optimise the design process, notably reducing time and associated costs. Furthermore, the CAD files are primarily converted into STL (Stereolithography) format, enabling compatibility with 3D printers (Shivraj, et al., 2021).

As we transition into the fourth industrial revolution, life as we know it is poised for transformation. The revolution is largely marked by digital business models and the ubiquitous Internet of Things (IoT) (Schwab, 2016). The industrial design landscape sees a surge in innovation, with strides made in domains like 3D printing and artificial intelligence. As the driving force behind this technological upheaval, 3D printing is anticipated to redefine manufacturing and our existence significantly (Schwab, 2016). These changes will reshape workplaces, leisure activities, daily life, and most importantly, cognition. With extended capabilities offered to artists, architects, designers, and engineers, 3D printing opens novel possibilities for traditional arts, thus re-establishing its relevance in an evolving digital world (Schwab, 2016).

1.2.2 Background of Rebab Melayu

The Rebab Melayu is a traditional musical instrument that holds a prominent position within the cultural and musical traditions of the Malay community, boasting a rich historical lineage spanning numerous centuries. Nevertheless, comprehensive

research is scarce on the origin and historical evolution of the Rebab Melayu, specifically focusing on the variant from Kelantan. The majority of the current scholarly literature primarily focuses on the Rebab instrument, which is widely recognized on a global scale. Its historical roots can be traced back to the Middle East and Central Asia (Dobbs, J. P. B., 1972, p. 194). The variant of Rebab Melayu originating from Kelantan exhibits unique characteristics that distinguish it from other regional variations of the instrument. The region of Kelantan is renowned for its distinctive playing techniques and repertoire, which exhibit a profound connection to the local culture and traditions. Despite the limited scope of existing research, concerted endeavours are being undertaken to safeguard and advance the preservation of this particular iteration of the Rebab, given its indispensable significance within the realm of Malay cultural heritage.

According to Salleh (1995), early evidence suggests that the introduction of the Rebab Melayu to the Malay archipelago was intricately linked to the spread of Islam in the region. The historical documentation found in the Malay Annals, or Sejarah Melayu, confirms the existence of this instrument during the 13th to 15th centuries. According to Nicolas (2017), the annals, which document the historical accounts of Malay kingdoms, provide explicit mentions of the Rebab Melayu as a musical embellishment within the context of royal courts. The aforementioned references indicate that the Rebab Melayu played a substantial cultural and societal function within the Malay archipelago during the specified historical era. The instrument likely served not only as a source of amusement but also held significance in religious and ceremonial contexts, thereby reinforcing its association with the dissemination of Islam in the area. The Rebab Melayu is utilised in a diverse range of traditional performances, including Wayang Melayu, Tarik Selampit,

Makyong, and Main Puteri. Following tradition, every performance typically integrates the Rebab Melayu alongside other musical instruments, including the gendang, gong, or Serunai Kelantan. The showcased performances effectively demonstrate the versatility and significance of the Rebab Melayu instrument in its role of preserving and promoting the cultural heritage of the Malay community. Furthermore, the role of the Rebab Melayu in these traditional performances serves to underscore its importance as a symbol of cohesion and collective revelry within the Malay community. One noteworthy instance is the Tarik Selampit, which is characterised by a solitary narrative presentation wherein the storyteller, referred to as Tok Selampit, recounts stories while being accompanied exclusively by the Rebab Melayu (Jusoh, C. M., 2011). The Tarik Selampit is an exceptional narrative technique that exclusively utilises the Rebab Melayu instrument to establish an enthralling and immersive encounter for the spectators. This exemplifies the instrument's capacity to elicit emotions and immerse listeners in the narrative's realm. The Tarik Selampit stands as a testament to the cultural significance of the Rebab Melayu and its capacity to uphold traditional storytelling practices within the Malay community.

The Rebab Melayu is distinguished by its unique musical style and tonal characteristics. The captivating ambience generated by the musician's adept execution, in conjunction with the melodic and evocative nature of the sound, engenders a mesmerising atmosphere that effectively captivates the audience's attention. The utilisation of the Rebab Melayu in narrative discourse serves the dual purpose of providing amusement and imparting knowledge, thereby facilitating the transmission of cultural values and traditions across successive generations. The conventional technique for holding this stringed instrument involves positioning it at an elevated position on the neck while

allowing the body to rest comfortably on the player's left knee. The tuning of its strings is frequently accomplished through the utilisation of the fifths or fourths system, resulting in a harmonious combination of melodic support intertwined with rhythmic elements. The performance technique commonly incorporates the utilisation of slides, bends, and vibrato, thereby enhancing the intricacy and resonance of the inherently captivating melody.

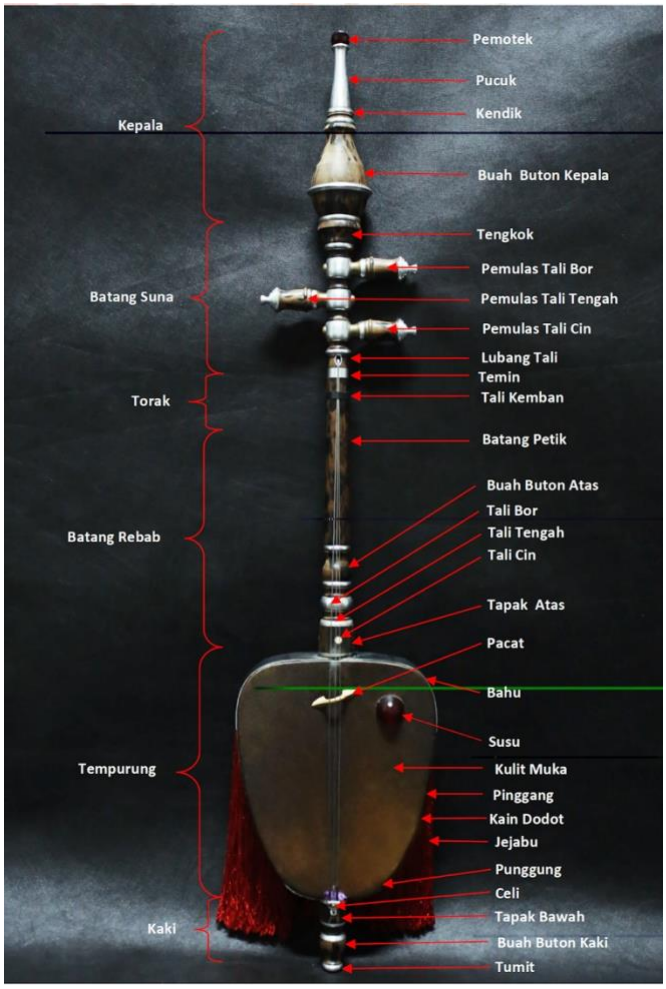

Plate 1.1: Parts of Rebab Melayu (Source: Che Mat Jusoh, 2018)

Based on Plate 1.1 above, there are six main parts of the Rebab Melayu; *Kepala, Batang Suna, Torak, Batang Rebab, Tempurung* and *Kaki*. Kepala Rebab Melayu is divided into four segments which are *Pemotek, Pucuk, Kendik* and *Buah Buton Kepala.* The *Kepala Rebab* functions as a balancer of the whole instrument as it is placed on the ground. *Batang Suna* or *Batang Serunai,* consists of *Tengkok, Pemulas,* and *Lubang Tali. Batang Suna* holds the *Pemulas* or tuner pegs for the three strings; *tali bor, tengah,* and *cin.* The *Torak* holds the *temin* (circular steel to strengthen the wood connection between the *torak* and *batang suna*) and *lubang tali* to insert the three strings through the small hole in it. *Batang Rebab* is where the fingering for the chords or plucking of the instrument happens but is limited to only Batang *petik* as illustrated in one plate 1.1.2. The body of the Rebab Melayu or *Tempurung,* includes the soundboard of the Rebab Melayu which is the *muka rebab* made by cow's stomach skin where the strings run in the middle of the Rebab. The strings are placed on top of a removable bridge called *pacat* or leech as it resembles the parasitic worm. On the top right of the face is *susu* which was made of wax from stingless bees or meliponines that function as sound dampeners. *Kaki* is the feet for Rebab Melayu resting on the ground as the way to play the instrument is by sitting cross-legged (Ghouse, N. M., 1989, Nik Mustapa, N. S., 1995; Jusoh C. M., Bidin, M. O, 2017; Zapri, M. Z., 2015).

1.2.3 Contemporary music instruments

Contemporary music features a diverse range of compositions that incorporate modern music concepts and merge them with innovative instruments. These instruments symbolise the cutting-edge in music and showcase the merging of contemporary trends and experimentation (Promusicianhub, 2022). One key aspect that characterises

contemporary music is the expansion of traditional acoustic instruments. For instance, artists like Max Richter and Nils Frahm employ inventive techniques on conventional instruments, such as prepared pianos, to create unique nuances in sound. The success and popularity of such approaches attest to the importance of continuously pushing the envelope in an ever-evolving musical landscape.

The development and adoption of electronic instruments mark another crucial development in contemporary music. As a departure from traditional acoustic instruments, electronic innovations such as synthesisers, samplers, and computer-based devices enable composers and musicians to manipulate sound in novel ways (Ekwuribe, E., 2022). Composer and performer Hans Zimmer serves as an example of this revolution, as his utilisation of synthesisers has significantly impacted the film scoring landscape. It could be argued that this expansion of available instruments has inevitably led to the wider variety and unique forms found in contemporary compositions, asserting the importance of technological integration.

Hybrid and unconventional instruments contribute another dimension to contemporary music's intrinsic experimentation (Promusicianhub, 2022). These instruments often combine elements from multiple sources or implement novel performance techniques, opening up unexplored sonic territories. One may argue that it is this willingness to experiment that defines the essence of contemporary music and contributes to its continued appeal and relevance. A noteworthy example of this trend is Bjork's project, in which a custom-made "gameleste," a hybrid of a gamelan and a celeste, was created to produce an unconventional sound palette, enriching her compositions in ways that traditional instruments could not achieve.

Apart from technological innovation, the contemporary music genre allows for diverse creative expression (Lock, S., 2022). Artists such as St. Vincent exemplify this ethos, fusing traditional rock guitar elements with electronic synths and beats, resulting in music that satisfies evolving tastes. Furthermore, one could argue that the continued blurring of genre boundaries, as well as the incorporation of avant-garde techniques and instrumentation, ensures that contemporary music remains dynamic and engaging at both local and global levels. In conclusion, contemporary music unifies modern concepts with an array of innovative instruments, melding traditional, electronic, and hybrid components to create uniquely versatile compositions. Embracing this diverse approach not only resets the boundaries of contemporary music but also ensures its continuous evolution by adapting to global audience preferences and musical advancements.

1.2.4 Recontextualize

In linguistics, a concept known as recontextualization refers to the process of extracting language, signs, or meanings from their original context and transplanting them into another context. This transition effectively alters the understood definition and meaning of those elements (Conolly, J. H., 2014). This concept offers a paradigm that extends to facets beyond linguistics. When related to musical instruments, for instance, recontextualization invites one to imagine the utilisation of an instrument, its conventional usage, or associated musical aspects within a novel, different musical environment.

A primary example of recontextualization in musical instrumentation is the utilisation of traditional instruments in unexpected genres or styles or the adopting unconventional playing techniques to devise novel sounds. The acoustic guitar offers a classic example. Widely associated with folksy or classical contexts (Bakan, M., 1999),

the acoustic guitar's recontextualization into genres such as jazz or rock music completely alters its sonic and stylistic impression. By disrupting the normative associations of the guitar in such a manner, the instrument's versatility is celebrated, and the dynamism of the genre itself is highlighted.

Recontextualization can further position itself within the creation of hybrid instruments, an area that combines elements from an assortment of pre-existing instruments or varying musical traditions. As musical reinterpretations, hybrid instruments embody features from diverse origins and cultures, thereby blurring classical categorizations between them (Zoran, A., 2011). This harmonisation of differences subsequently promotes new possibilities for auditory experiences and paves the way for a global fusion of tonalities and musical expressions. The creation of such fusion-based electronic instruments demonstrates recontextualization, as they juxtapose acoustic and synthetic components to extend composers' and performers' sonic and textural palettes.

Likewise, the recontextualization process is not limited to the creation of novel instruments; it can also embrace the adaptation or reinterpretation of traditional musical instruments within modern contexts. In such cases, transformations might involve altering tonal qualities, enhancing the instrument's capabilities, or investigating previously unexplored performance avenues with the aid of modern tools and techniques. A fitting illustration is the transformation of classical instruments via effects pedals or electronic processing. Such techniques imbue traditional instruments with a novel, sonic identity that enables integration into contemporary experimental or electronic genres (Fletcher, N. H., 1998; Thibodeau, J., & Wanderley, M. M., 2013). This reinvention challenges

conventional thought that boxes instruments into prescribed boundaries and nudges music towards innovation.

In conclusion, when it comes to musical instruments, recontextualization manifests as an embracing of pre-existing instruments, concepts, or musical elements in fresh, compelling contexts. By celebrating fluidity and fostering continuous evolution in both instrumental usage and associated terminologies, recontextualization refreshes the realm of musical expression, facilitating the conception of cutting-edge sounds that align with progressive musical appetites.

1.3 Problem Statement

Bouma and Ling (2004) define research problems as the 'issues that lead to the initiation of research' indicating they serve as the fundamental pivot around which the entire research work rotates. The rapid development and innovation in the design world pose new challenges and opportunities to innovate traditional practices, such as the construction process of the Rebab Melayu, a traditional musical instrument. By examining the research problem - maintaining the traditional essence of Rebab Melayu while integrating modern technological advancements - this study intends to offer a revolutionary perspective on the innovation of traditional musical instruments (Bouma & Ling, 2004).

The Rebab Melayu occupies a position of prominence within the array of musical instruments indigenous to Kelantan. Individuals who attain proficiency in its execution are held in high regard, as they embody a comprehensive mastery over Kelantan's musical performance traditions (Jusoh, C. M., 2011). Beyond its role as a melodic apparatus, the

Rebab Melayu assumes a symbolic significance, encapsulating the cultural identity of Kelantan through its resonant tonal expressions (Ghouse, N. M., 1989). As the apex of Kelantan's musical instrumentation, the Rebab Melayu serves as a conduit for the preservation and transmission of the region's musical heritage, solidifying its place as a symbol of artistic excellence and cultural continuity. However, in contemporary times, the utilisation of the Rebab Melayu is predominantly observed within the domains of Makyong and Main Puteri performances (Jusoh, C. M., Bidin, M. O., 2017). Makyong, a form of theatrical musical presentation, designates the Rebab Melayu as the principal carrier of melodic motifs throughout the performance. Conversely, in the context of Main Puteri, a healing ritual, the Rebab Melayu shares its role with the Serunai Kelantan, a traditional flute instrument. Besides, the Rebab Melayu's historical role encompassed two additional cultural performances, namely Wayang Melayu and Tarik Selampit. Regrettably, the practice of these two performances has waned in the contemporary era, reflecting the evolving dynamics of the modern world and its impact on traditional cultural expressions.

Despite receiving UNESCO recognition in 2005, the Makyong performance has experienced a decline in its prevalence. This deterioration can be attributed partly to the inadequate implementation efforts by the Ministry of Culture, Arts, and Heritage after its UNESCO acknowledgement. Furthermore, the erosion of Makyong has been expedited by the passing away of elder practitioners who possessed a more profound comprehension of the art's intricacies (Yousof, G. S., 2011). This observation is reiterated by the same author in 2016, who underscores the contributory factors such as diminishing audiences, constrained performance opportunities, the encroachment of modernization, the allure of

alternative media platforms, notably films, a paucity of financial backing, and the influence of religious considerations (Yousof, G. S., 2017).

Similarly, the traditional therapeutic practice of Main Puteri is undergoing a gradual decline. This decline is substantiated by factors such as the ascendancy of modern medical practices and the enhanced accessibility of contemporary healthcare services to the local populace of Kelantan. The availability of hospitals and clinics within proximity, a marked departure from the past when such facilities were concentrated primarily in urban centres or cities, has contributed to the fading prevalence of Main Puteri as a therapeutic healing art (Ghouse, N. M., 2014). While the practice of Rebab Melayu endures in the contemporary milieu, its usage remains confined exclusively to the two aforementioned performances, Makyong and Main Puteri. This restricted application subsequently imposes limitations on the versatility and broader integration of the Rebab Melayu within the diverse cultural tapestry of Malaysia.

The Rebab Melayu, a quintessential component within the traditional Malay music ensemble, is facing significant challenges in a rapidly modernising world (Zapri, M. Z., 2015). Its unique design and distinctive sound, entrenched in centuries of cultural evolution, are at risk of being overshadowed as technology continues to shape our future. This prompts a fundamental research question: can modern technology work hand in hand with tradition to preserve and carry forward such invaluable cultural heritage? The concerns that spark this inquiry are manifold.

The design and sound of the Rebab Melayu emanate from years of traditional wisdom and lie at the core of its cultural significance. Its distinctive shape, size, and

material contribute not only to its aesthetic realness but also to its specific sound properties. However, scientific explorations detailing these key characteristics and their interplay remain scarce. This knowledge gap makes it challenging to replicate or modernise the instrument. Without a doubt, there is a distinct need to conduct in-depth research to identify these underlying attributes and understand how they contribute to the overall essence of the Rebab Melayu.

Besides the issue of replicability, another concern pertains to the sustainability of the natural materials traditionally deployed in the construction of the Rebab Melayu. These materials, intrinsic to the instrument's authentic texture and sound, are becoming increasingly scarce due to a host of reasons, including environmental considerations and accessibility constraints. The potential environmental damage resulting from the excessive extraction of these materials is worth pondering (Azhar, A. L., et. al, 2019). As the sustainability debate gains momentum in various aspects of human life, the future production of the Rebab Melayu is no exception. Consequently, the quest arises for alternative materials capable of mirroring the physical and acoustic properties of the naturally sourced materials while being eco-friendly and more accessible to ensure a more sustainable future for the instrument.

In addition to the material considerations, the drive for modernization led to the idea of introducing mass production methods for the Rebab Melayu. Traditionally, this instrument's creation is an artisanal process, each piece a work of painstaking craftsmanship (Nik Mustapha, N. M. S., 1995). However, this approach contrasts with the modern industrial rhythm demanding quick and mass-scale production. There is an undeniable apprehension that mass production while ensuring the Rebab's relevance,

might risk diluting its authenticity and its original sound. Therefore, the challenge lies in identifying methods to adopt an industrial production process without impeding the inherent spirit and sound character of the Rebab Melayu. Cumulatively, these concerns point towards an urgent need to modernise the Rebab Melayu instrument while preserving its traditional essence (Zapri, M. Z., 2015). Alongside preserving this core identity, the adapted version should be able to cope with the practicalities of mass production and sustainability. Herein lies a dynamic tension — the balance between continuity and change, tradition and innovation, authenticity and practicality.

Therefore, an innovative approach that seeks a resolution is to embrace the potential of other technologies to overcome the scarcity of materials in sustaining the existence of Rebab Melayu (Azhar, A. L., et. al, 2019). Over the past few years, 3D Printing technology has displayed profound capabilities to create complex designs with a variety of materials. As such, it can offer a promising platform for replicating the Rebab Melayu, imbuing it with an adaptable character without sacrificing its cultural and acoustic integrity. Consequently, it becomes imperative to conduct research that explores the feasibility, merits, and potential challenges of creating a 3D-printed version of the Rebab Melayu. Such an exploration not only enables the development of a practically viable rendition of the traditional instrument but also provides insights into the larger interplay between traditional arts and modern technology.

In conclusion, the research vitalizes the attempt to reconcile tradition with technology, bridging the Rebab Melayu with the contemporary rhythm of life using 3D printing technology. By answering critical questions about the nature and modern adaptation of the Rebab Melayu, it promises to contribute to our understanding of

technology's role in preserving, enhancing, and disseminating cultural heritage. Furthermore, it potentially creates a template for future endeavours seeking to find harmony between the reverence for original art forms and the allure of technological advances. Hence, the research's problem statements are listed below:

- The Rebab Melayu, a traditional Malay instrument, is losing its relevance due to modernization and technology, endangering its cultural value and heritage
- The materials traditionally used for constructing the Rebab Melayu are becoming increasingly scarce due to environmental issues and accessibility constraints. This situation could potentially affect the sustainability of the instrument's production
- The idea of using 3D printing technology to replicate the Rebab Melayu, while promising, needs a comprehensive examination to understand its potential challenges, merits, and feasibility.

1.4 Research Questions.

The research seeks to address several fundamental questions that underline the potential and challenges of adapting the Rebab Melayu through the implementation of 3D printing technology. Considering the objectives of this research, four primary research questions have been formulated:

1. What are the characteristics of the traditional Rebab Melayu?
2. How does the implementation of the 3D printing technology could be used in reproducing the contemporary Rebab Melayu?

3. How can the 3D Printed Rebab be presented to get professional feedback and audience response on the innovative instrument?

4. How does using 3D printing technology influence the construction, functionality, and sound quality of the Rebab instrument, as demonstrated in the making process and performance in the video?

1.5 Research Objectives

This study aims to explore the traditional Rebab Melayu, a musical instrument integral to Malay culture, and adapt it using modern 3D technology. The primary objectives of this study includes:

1. To identify the characteristics of the traditional Rebab Melayu.

2. To implement the 3D printing technology in reproducing the contemporary Rebab Melayu.

3. To test the 3D Printed Rebab by composing a short video of the making process and playing the instrument.

4. To analyse the professionals' feedback and audience response to the 3D printed Rebab Melayu.

A comprehensive investigation into the traditional Rebab Melayu is required to accomplish this goal. To develop an in-depth understanding of the instrument, it is important to acquire a thorough grasp of its construction attributes (such as materials, form, and size), tonal qualities, historical provenance, cultural importance, and its position

within the context of Malay traditional music. The establishment of this foundation is of utmost importance for the subsequent objectives, as it establishes the standard against which the modern, three-dimensional printed Rebab Melayu will be assessed and analysed. With a thorough understanding of the traditional Rebab Melayu, the next step involves leveraging 3D printing technology to recreate this instrument in a modern context. The objective here is to design and produce a 3D-printed version of the Rebab Melayu that maintains its essential characteristics but embraces new construction methods. This could involve using different materials or adapting certain features to suit the constraints and possibilities provided by 3D printing technology.

This stage involves engagement with traditional practitioners of the Rebab Melayu to gather thorough, expert feedback about the modern interpretation of the instrument. Practitioners who are familiar with the traditional instrument can offer valuable insights regarding the accuracy of the 3D printed version in replicating the original's characteristics. They can provide feedback on the instrument's playability, sound quality, and overall design, which can be used to refine the 3D-printed version and make it as faithful to the traditional instrument as possible.

The final objective involves assessing public perception of the new, 3D-printed Rebab Melayu. Using performances featuring the modern instrument, the research will gather audience reactions to its sound and appearance. This objective is key to understanding the broader acceptance of the instrument and determining its success in maintaining the appeal of the traditional Rebab Melayu while incorporating modern technological advancements. Public feedback can also offer insights into potential areas for further research and development. Hence, through these objectives, the research seeks to bridge the gap

between traditional Malay instruments (Rebab Melayu) and modern technological innovations (3D printing), ultimately offering valuable insights about the role of technology in recontextualizing and contemporary traditional music instruments.

Table 1.1: Summary of Problem Statement, Research Questions and Objectives

Problem Statements	Research Question	Research Objectives
The Rebab Melayu, a traditional Malay instrument, is losing its relevance due to modernization and technology, endangering its cultural value and heritage	What are the characteristics of the traditional Rebab Melayu?	To identify the characteristics and essence of the traditional Rebab Melayu and Contemporary Music.
The materials traditionally used for constructing the Rebab Melayu are becoming increasingly scarce due to environmental issues and accessibility constraints. This situation could potentially affect the sustainability of the instrument's production	How does the implementation of the 3D printing technology could be used in reproducing the contemporary Rebab Melayu?	To implement the 3D printing technology in reproducing the contemporary Rebab Melayu.
The idea of using 3D printing technology to replicate the Rebab Melayu, while promising, needs a comprehensive examination to understand its potential challenges, merits, and feasibility.	How can the 3D Printed Rebab be presented to get professional feedback and audience response on the innovative instrument?	To examine the feedback of the contemporary 3D printed Rebab Melayu based on the traditional practitioners' perspective.
	How does using 3D printing technology influence the construction, functionality, and sound quality of the Rebab instrument, as	To analyse the audience response to the music performance of the contemporary 3D

	demonstrated in the making process and performance in the video?	printed Rebab Melayu.

1.6 Scope and Limitations of study

The research scope of this study is carefully defined and clearly outlined. Malaysia's artistic landscape is renowned for its diverse traditional performances, which exemplify a rich cultural tapestry resulting from the amalgamation of various ethnicities and cultures. Frequently, these performances integrate a diverse range of distinctive musical instruments, which play a crucial role in traditional art forms primarily centred around music, such as Makyong. Therefore, the present study adopts a narrowed scope, concentrating on a singular musical instrument known as the Rebab Melayu as this instrument holds significance within the context of Makyong performances, which are indigenous theatrical forms originating from Malaysia.

Furthermore, since the current state of the Rebab Melayu, in terms of its creation and performance, is at a critical juncture, characterised by a scarcity of skilled artisans and musicians. Therefore, this research project commenced by engaging in a dialogue with Raja Rebab, Mr. Che Mat Jusoh, an individual of significant expertise in this specific domain. His extensive knowledge, understanding and practised skill in the creation of the instrument and performance of the Rebab Melayu, coupled with his network of trusted practitioners and artisans similarly dedicated to this craft, provided invaluable insights. His introduction to these artisans drove a deeper understanding of the construction practice and the stringent quality standards of Rebab Melayu production.

The location depends on the *Adiguru* where the makers are active such as Penang, Kelantan, Kuala Lumpur and Singapore. The researcher chose this location based on *Adiguru*'s recommendation as long as he follows him in learning more about the essence of Rebab Melayu. *Adiguru* Che Mat Jusoh is well-known not just to the community of Kelantan traditional performance art but also throughout Malaysia as the Raja Rebab. His work and skills in making, innovating and playing the Rebab Melayu for more than forty years are the reason the researcher got close to him in finding out the root problem of the traditional musical instrument. From his information and guidance, the researcher found four more practitioners in the art to explore more about the subject. The researcher needs to find out the practitioners who are active in playing while producing Rebab Melayu for the community.

As the researcher is not well versed in musicology, this study will focus on identifying the characteristics of the instrument and making process of Rebab Melayu. by looking into the process the researcher aims to produce the instrument through replication of the soundboard and other parts is crucial in producing the sound. Augmented audio tools will be experimented with the Rebab Melayu to complement the possible deficiency of sound production. The 3D Printing process, which includes CAD software such as Rhinoceros 3D and Fused-Deposition Modeling 3D Printer, will be used to create a working prototype of the Rebab Melayu. The traditional instrument will serve as a design template, with the elements of form, shape, and texture guiding the researcher through the design process. The UK Design Council's theory of innovation and systematic design framework will be used to guide the entire innovation process. In this study, Practised-Based Research is used as the methodology to achieve the research objectives and answer