

3D PRINTING TECHNOLOGIES IN SABAH HANDICRAFT INDUSTRY: A PRELIMINARY INVESTIGATION

Lilian Lee Shiau Gee^{1*}
Saila Saidie²

¹ Academy of Art and Creative Technology, 88400, Universiti Malaysia Sabah, MALAYSIA

² LJD Cooperation Sdn Bhd, 88450, Kota Kinabalu, Sabah, MALAYSIA

lilian@ums.edu.my*

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ABSTRACT

To enter emerging markets, it is necessary to revitalise and modernise handmade items, crafts, and souvenirs. The preservation of Borneo's artisan handicrafts and traditional techniques, which are directed by generational knowledge, necessitates the introduction of new offers to invigorate the growth of these traditional crafts that are at risk of fading. The progress of 3D printing enables the exploration of personalisation, uniqueness, and creativity, which may contribute to the diversification of Borneo handcrafted items. Hence, the integration of innovative technologies and materials may be enthusiastically adopted by local artisans and the expansion of technology as an independent domain capable of manufacturing a diverse array of craft products can enhance their production, competitiveness, and prospects for sustainability. The desire to include state-of-the-art technology in the construction of mementos raises several philosophical and ethical concerns that need to be addressed. The study suggests that further investigation should be conducted to explore the advantages and disadvantages of 3D printed mementos for various client categories. Incorporating the cultural heritage of the Borneo people into product design, together with the use of digital manufacturing technologies, may ultimately create fresh value, enhance resilience, and promote sustainability for local handcrafted items.

Keywords: 3D Printing, Sabah Handicraft, Design Intervention, Local Artisan, consumer preferences.

INTRODUCTION

Handmade products, crafts, and souvenirs must be reinvented and updated to penetrate new markets. Borneo artisan handicrafts and traditional procedures guided by generational expertise require fresh offerings to stimulate the development of traditional crafts that are on the verge of extinction. The advancement of 3D printing opens possibilities for personalisation, originality, and inventiveness, which can help to diversify the patterns of Borneo handmade goods such as the Neo-handmade theme. As a term for the design of consumer goods, "Neo-Craft" describes an approach in which folk traditions and the wealth of cultural manifestations maintained by ethnic groups over generations are combined with innovative approaches to production using non-traditional materials and processes to create a new typology of products. Therefore, the incorporation of new technologies and materials can be favourably embraced by local craft entrepreneurs, and the growth of technology as a separate area capable of producing a wide range of craft items can boost their output, competitiveness, and possibilities of staying in business.

This study seeks to fill this gap and enhance the current understanding of local handicraft heritage as a significant aspect of art and culture, which is being redefined by technological advancements, the growth of creative tourism, and the local artisan economy. The paper analyzes consumer perceptions of handicrafts integrated with adaptable 3D printing and addresses the challenges of employing 3D printing as a manufacturing technique that maintains traditional artisanal practices, offering valuable insights into the preservation and revitalization of traditional crafts through technological innovations.

CULTURAL, HERITAGE AND TRADITIONAL HANDICRAFT

Handicrafts are often defined as handmade products of significant artistic and visually value (Kamaruddin, 2020; Oza Megha, 2019). The items of "Sabah Crafts" are more than only decorative or wearable; they are also an essential manifestation of Sabah's ethnic cultural identity. Sabah handicrafts are inextricably linked to the traditions, heritage, and daily lives of Sabah's ethnic communities. Craft products play a crucial role in conserving and promoting Sabah's traditional heritage and artistic expression. Their central role in many events, festivals, and cultures emphasizes their significance as cultural symbols, spanning the past and present and uniting generations via artistic expression.

However, producing local craft goods based solely on folk festivals and rites is inadequate; the craft industry must adapt to current market trends. Most local craft entrepreneurs struggle to sell their products in the face of shifting modern trends, which emphasizes the necessity for innovation in local craft manufacturing. Handicrafts, as a sub-sector of the creative industry, fall somewhere between art and design, with final products ranging from works of art to practical products to decorative or ornamental artifacts. Innovation in craft products as part of the creative business is required to assist craft enterprises in increasing sales. To win market competition, craft entrepreneurs must continually try to develop new craft items that raise the attractiveness of the products given to the market and strengthen the originality of the products, resulting in customer variation and globalization.

TRADITIONAL HANDICRAFT PRODUCTION AND INNOVATION

The production of handicrafts in Sabah is a multifaceted process that necessitates advanced artisan skills, sustainable raw resources, and a profound comprehension of the significance of craft culture. Traditionally, artisan crafting skills are passed down from parents to offspring or through several generations. The primary raw materials utilized are natural resources, including bark, wood, plant foliage, clay, and metal. The manufacturing of craft items

is typically managed by a family and their relatives during the full production process. Most of their commercial operations consist of micro-enterprises conducted in informal settings, such as home-based environments. These products are typically manufactured in rural regions, predominantly by women, as handicraft work is historically linked to the domestic roles of wives and mothers, often serving as supplementary employment at home.

Considering the challenges encountered by handicraft enterprises in Sabah, innovation is required in three primary domains: i) Technological innovation to enhance productivity in labor-intensive operations; ii) Innovation in materials to guarantee a consistent supply of manufactured resources, addressing the primary challenge faced by craft entrepreneurs in accessing increasingly scarce natural resources in rural areas. Moreover, replanting trees and bamboo is a protracted endeavor; additionally, innovation regarding product appeal in design and functionality is essential for developing new craft products that cater to local consumers and cultural resources (souvenirs) for tourists and international culture aficionados.

INNOVATION ASPECTS IN TRADITIONAL HANDICRAFT DEVELOPMENTS

The handicraft sector encounters numerous obstacles, such as competition from mass-produced items, evolving consumer preferences, and restricted access to technologies and markets. In the arts and design sector, promoting innovation in handicrafts is crucial by emphasizing design transformation, technology integration, sustainability, branding, and skills development; these crafts can attain economic growth while preserving the essence of Sabah's ethnic culture.

Design Creativity

Enhancing rural handicrafts can be most effectively achieved through innovative design. Conventional designs frequently carry cultural symbolism yet may not correspond with contemporary consumer inclinations. The capacity of craftspeople to distinguish themselves from rivals through the creation of unique designs. Integrating contemporary design into traditional crafts can attract a varied audience (Alfoldy, 2007). Furthermore, developing multifunctional products like decorative things that fulfill utilitarian roles—such as rattan ‘bubu’ utilized for fishing—enhances their marketability as decorative lamps. Research indicates that design innovation can enhance the perceived value of conventional items, consequently augmenting their overall market competitiveness (Roy & Mohapatra, 2023). Innovative handicrafts can facilitate the entrepreneurship of rural craftspeople, highlighting a gap in prior research.

Technology Integration

Technology serves as a potent catalyst for innovation in rural handicrafts. Computer-aided design (CAD) methodologies can enhance accuracy and productivity in manufacturing while preserving the characteristics of handcrafted items. (Pasricha & Greeninger, 2018). Technological tools serve as complimentary instruments, enabling craftsmen to expand creative limits, enhance the accessibility of handicrafts, and attract a broader, contemporary audience while preserving the fundamental character of traditional craftsmanship. 3D modeling software and 3D printing can facilitate sustainable production techniques and transform their craft (Zhang, 2023). Contemporary and modern technologies can enhance creativity and promote the integration of traditional and modern practices.

Sustainability Practices

Current consumers are progressively insisting on eco-friendly and ethically manufactured products, rendering sustainability a crucial element of innovation. Local handicrafts can incorporate sustainable practices through the utilization of biodegradable materials, the implementation of waste reduction measures, and the recycling of resources. Utilizing discarded plastic and recycled materials to manufacture sustainable home decor products, which are in great demand in the global market (Otjela & Folcut, 2019). Recycling waste materials from production not only reduces waste but also enhances the product's value, hence augmenting its attractiveness.

Consumer Preferences and Trends

Comprehending client preferences is crucial for modifying handicrafts to meet contemporary wants. Entrepreneurs must market handicrafts by aligning with their clients' desires and expectations (Nayak and Bhalla, 2016; Nguyen, 2024). This component is intricately linked to the development, testing, and market introduction of innovative products. Market research is essential to discover emerging trends in craft product design, like the increasing desire for sustainable products and minimalist aesthetics. By incorporating these trends, craftsmen can produce items that align with modern lives while preserving their distinct personality.

3D Printing integration in Traditional Handicrafts

Modernization poses an ever-increasing challenge to this traditional craft. Moreover, the cost of traditional materials is rising, and the number of qualified craftsmen is decreasing (Mhd Hanif et.al 2024). This presents an opportunity for 3D printing to serve as an alternative method that can accommodate modern demands while preserving local handicraft production (Ye, 20. 3D printing enables artisans to allocate additional time and concentrate on product design concepts, while 3D printing machines can automate manufacturing duties. 3D printing can serve as a supplement to, rather than a substitute for, the skills of artisans.

3D printing has given unprecedented opportunities for design variation. 3D printing projects enable craftspeople to enhance their creations and respond to evolving market demands. 3D printing enables artisans to transcend creative limitations, allowing them to broaden their design concepts and innovate, particularly in complex designs and traditional craft methods that are frequently restricted by existing tools and procedures. This enables craftspeople to reinterpret ancient themes and patterns innovatively, preserving their craft with contemporary elegance.

A significant advantage of 3D printing in handicrafts is its capacity to fulfill the desire for personalization. Artisans can utilize 3D printing to produce distinctive creations customized to their clients' particular desires. Artisans may manufacture limited edition products to augment the distinctiveness of their commodities on the market, thereby attracting consumers. Artisans can create and print beads for accessory products according to the customer's motif, color, symbol, or design preference. This degree of customisation was once unachievable without considerable effort or cost.

3D printing can mitigate sustainability concerns by reducing waste and utilizing eco-friendly materials (Olawumi et.al. 2023). For instance, 3D printing utilizes only the necessary materials for designing and use biodegradable PLA filament sourced from renewable resources like cornstarch to manufacture the requisite quantity of things. This may also enhance production efficiency, effectiveness, and enable small batch manufacturing. Moreover, the utilization of recycled fibers diminishes their ecological footprint while satisfying the requirements of ecologically aware clients.

3D printing contributes to the preservation and advancement of cultural heritage by digitizing traditional patterns, thereby safeguarding digital files of these patterns for future

generations. 3D modeling software and 3D printing enable the reproduction of motif pattern designs as digital models for external craftspeople' reference and serve as educational tools for young artisans, thereby streamlining the production of local crafts.

The incorporation of 3D printing into handicrafts offers numerous advantages; nonetheless, issues related to preservation and accessibility persist. The incorporation of 3D printing presents issues related to: i) the adjustment of businesses to this novel instrument in the absence of adequate training and assistance; ii) the customer perception of the 'authenticity' and 'innovation' associated with the integration of 3D printing into local crafts. This study seeks to investigate the potential and acceptance of 3D printed craft products among entrepreneurs and consumers, emphasizing the significance of understanding the advantages of 3D printing technology and the possible cultural ramifications of embracing this contemporary innovation.

METHODS

In this study, a quantitative approach was used to examine: i) the acceptance of 3D printing in craft processing by local entrepreneurs and ii) consumer acceptance of crafts produced by 3D printing (Neo-Craft) as an attraction for product purchase. A questionnaire was prepared and this study involved 140 respondents. A 5 Point Likert Scale was used as a measurement with 1 representing “Strongly Disagree” and 5 representing “Strongly Agree”.

RESULTS ANALYSIS

3D Printing Understanding

Table 1: Percentage of Understanding Aspects

| No. | Item | SD | D | QA | A | SA |
|-----|--|------|------|-------|--------------|--------------|
| 1 | I have heard about 3D Printing. | 2.9% | 1.4% | 20.0% | 41.4% | 34.3% |
| 2 | I have seen 3D printing products. | 4.3% | 2.9% | 11.4% | 34.3% | 47.1% |
| 3 | I think 3D printing is great. | 2.9% | 5.7% | 30.0% | 22.9% | 38.6% |
| 4 | I would like to know more about 3D Printing. | 2.9% | 4.3% | 17.1% | 35.7% | 40.0% |

Table 1 provides valuable insights into consumer perspectives on 3D printing, focusing on their awareness, exposure, perceptions, and interest in learning more about technology. The data reveals that 75.7% of respondents are familiar with 3D printing, as reflected in their agreement or strong agreement with the statement “I have heard about 3D Printing.” This widespread awareness suggests that 3D printing is no longer a niche technology but has entered the general consciousness, likely due to increased media coverage, marketing efforts, and the integration of 3D printing in consumer products.

Exposure to 3D-printed products also appears to be relatively high, with approximately 80% of respondents agreeing or strongly agreeing to having seen 3D printing products. This indicates that 3D printing is reaching consumers through tangible goods, such as custom items, prototypes, or even household and fashion products. However, a smaller portion of the respondents (about 20%) expressed neutrality or disagreement, which could point to limited market penetration in certain demographics or a lack of recognition of 3D-printed products in everyday use.

Consumer sentiment toward 3D printing is overwhelmingly positive, as 61.5% of respondents agreed and strongly agreed with the statement “I think 3D printing is great.” This positive perception reflects the growing appeal of 3D printing’s potential to create customized, innovative, and sustainable products. For many consumers, the ability to personalize goods, reduce waste, and participate in creative processes is a significant advantage of this technology. Additionally, the strong interest in learning more about 3D printing, with 40% strongly agreeing and 35.7% agreeing to the statement “I like to know more about 3D Printing,” demonstrates that consumers are curious and eager to engage further with this evolving technology.

From a consumer perspective, these findings suggest that while awareness and positive perceptions of 3D printing are high, there is still room to enhance visibility and accessibility to its products. Businesses and educators could leverage this strong interest by providing more hands-on experiences, workshops, or targeted marketing campaigns to bridge the gap between awareness and adoption. The data also highlights an opportunity for companies to innovate and expand their product offerings, tapping into the enthusiasm of consumers eager to explore and benefit from the possibilities of 3D printing technology.

Innovation Level

Table 2: Percentages of Innovation Level

| No. | Item | SD | D | QA | A | SA |
|-----|---|------|------|-------|--------------|--------------|
| 1 | I prefer to buy local community handicrafts with an innovative design. | 2.9% | 1.4% | 20.0% | 41.4% | 34.3% |
| 2 | I prefer to buy local community handicrafts with designs that capture unique cultural aspects. | 4.3% | 2.9% | 11.4% | 34.3% | 47.1% |
| 3 | I prefer to buy local handicrafts that have been designed to follow the latest trends and fashions. | 2.9% | 5.7% | 30.0% | 22.9% | 38.6% |
| 4 | I prefer to buy local community handicrafts that are made from sustainable raw materials. | 2.9% | 4.3% | 17.1% | 35.7% | 40.0% |

Table 2 reflects consumer preferences for local community handicrafts, emphasizing innovation, design, and uniqueness. It shows that a substantial proportion of consumers value innovative and creative designs in local products.

The highest preference is evident in Item 2, where 47.1% of respondents strongly agree that they value handicrafts with designs capturing unique cultural aspects, highlighting a significant inclination toward culturally rich products. This indicates a significant appreciation for products that reflect cultural heritage and authenticity, suggesting that consumers highly value the preservation and representation of cultural identity in their purchases.

Similarly, innovative designs in handicrafts (Item 1) are favored, with 41.4% agreeing and 34.3% strongly agreeing, showing a strong demand for creativity in craftsmanship. This demonstrates a clear consumer inclination toward creativity and originality in handicrafts, emphasizing the appeal of products that stand out due to their modern or unique design elements. These findings underscore the relevance of innovation in maintaining the competitiveness of local crafts in contemporary markets.

Item 3 addresses consumer interest in handicrafts designed to follow the latest trends and fashions, with 38.6% strongly agreeing and 22.9% agreeing. While this attribute is slightly less favored compared to others, it still highlights a notable segment of consumers who value trendy and fashionable designs, indicating that some buyers associate aesthetic appeal with modernity and style.

Finally, sustainable raw material usage in handicrafts (Item 4) is also highly valued, with 40% strongly agreeing and 35.7% agreeing, reflecting the growing consumer consciousness toward eco-friendly products. These findings suggest a robust preference for handicrafts that balance cultural, innovative, trendy, and sustainable attributes. Such preferences align with global trends that encourage sustainability and responsible production.

Sustainability Engagement

Table 3: Percentages of Sustainability Engagement

| No. | Item | SD | D | QA | A | SA |
|-----|--|------|-------|-------|--------------|-------|
| 1 | I will hear more about the environmental sustainability initiatives by local artisans to produce craft products. | 4.3% | 5.7% | 24.3% | 41.4% | 24.3% |
| 2 | Having knowledge of whether craft products have environmental sustainability initiatives may affect my purchasing decisions. | 4.3% | 2.9% | 22.9% | 41.4% | 28.6% |
| 3 | Learn more about whether a craft product's social sustainability initiatives may affect my purchasing decisions. | 4.3% | 10.0% | 17.1% | 48.6% | 20.0% |
| 4 | For me, environmental and social issues related to production and the use of the product are a concern for me. | 4.3% | 8.6% | 12.9% | 42.9% | 31.4% |

The survey results provide valuable insights into consumer attitudes toward sustainability initiatives in the context of craft products, reflecting a growing awareness and prioritization of environmental and social concerns. For the first item, "I will hear more about the environmental sustainability initiatives by local artisans to produce craft products," a significant majority (65.7%) respondents expressed agreement or strong agreement, indicating a clear interest in learning more about the environmental efforts made by local artisans. This suggests that consumers are increasingly attentive to sustainability narratives and view them as an essential aspect of artisanal products.

The second item, "Having knowledge of whether craft products have environmental sustainability initiatives may affect my purchasing decisions," received an even stronger agreement, with 70% of respondents agreeing or strongly agreeing. This finding underscores the practical implications of sustainability knowledge, as it directly influences consumer behavior and purchasing decisions. It highlights the importance for artisans and producers to effectively communicate their environmental efforts, as transparency in sustainability can serve as a critical factor in shaping market preferences.

Social sustainability also plays a significant role, as evidenced by the responses to the third item, "Learn more about whether a craft product's social sustainability initiatives may affect my purchasing decisions." Here, 68.6% of respondents agreed or strongly agreed, demonstrating that consumers are equally concerned about the social dimensions of sustainability, such as fair labor practices and community impact. This aligns with broader consumer trends emphasizing ethical consumption and social responsibility.

Finally, the fourth item, "For me, environmental and social issues related to production and the use of the product are a concern for me," elicited the strongest agreement, with 74.3% of respondents expressing concern about these issues. This indicates that sustainability is not merely a peripheral interest but a central concern for many respondents. The high level of agreement across all four statements suggests that sustainability, both environmentally and social, is a critical factor in consumer engagement with craft products. For businesses and artisans, these findings highlight the need to integrate and communicate sustainability practices effectively to meet consumer expectations and enhance market appeal.

Uniqueness Imperative

Table 4: Percentages of Uniqueness Imperative

| No. | Item | SD | D | QA | A | SA |
|-----|--|------|-------|-------|--------------|-------|
| 1 | I am often looking for new handicraft products to add to my personal uniqueness. | 4.3% | 10.0% | 25.7% | 41.4% | 18.6% |
| 2 | I am easily attracted to interesting and unusual handicraft products that help me create a distinctive image. | 4.3% | 5.7% | 18.6% | 41.4% | 30.0% |
| 3 | I often try to find more interesting versions of handicraft products because I like to be creative and modern. | 5.7% | 8.6% | 12.9% | 40.0% | 32.9% |
| 4 | I will buy new handicraft products that I have not seen before. | 7.1% | 7.1% | 24.3% | 32.9% | 28.6% |

The Table 4 provided highlights the critical role that uniqueness plays in influencing consumer behavior when purchasing handcrafted products. Uniqueness, as a defining characteristic of handicrafts, appeals to consumers' desire for self-expression, creativity, and individuality, making it a key factor in their buying decisions.

The first item, "I am often looking for new handicraft products to add to my personal uniqueness," reflects how consumers view handcrafted items as tools to enhance their personal identity. With 41.4% agreeing and 18.6% strongly agreeing, it is evident that many respondents actively seek products that can distinguish them from others. This underscores the uniqueness imperative, where consumers are not merely purchasing for functionality but to assert their individuality. Handcrafted products, with their one-of-a-kind designs and artisanal touches, serve as symbolic markers of personality and exclusivity.

Similarly, the influence of uniqueness is further reinforced by the responses to the second statement, "I am easily attracted to interesting and unusual handcrafted products that help me create a distinctive image." Here, 41.4% agreed and 30% strongly agreed, revealing that nearly three-fourths of the participants value the uniqueness and aesthetic appeal in handicraft products. The finding suggests that the more a product deviates from mass-market homogeneity, the more appealing it becomes to consumers. Unique handicrafts resonate deeply with consumers seeking to align their purchases with personal values, such as exclusivity, cultural identity, and artistic appreciation. This indicates that artisans who emphasize distinctive designs, materials, and craftsmanship are more likely to attract and retain customers.

The third item, "I often try to find more interesting versions of handcrafted products because I like to be creative and modern," reflects consumers' desire for creative engagement. A combined 72.9% of respondents agreed or strongly agreed, suggesting that a significant portion of the audience prioritizes creativity and modernity when selecting handcrafted items. This reinforces the importance of continuously innovating and diversifying product offerings to meet the expectations of a dynamic and design-conscious consumer base.

Finally, the fourth item, "I will buy new handcrafted products that I have not seen before," highlights the novelty aspect tied to uniqueness. With 32.9% agreeing and 28.6% strongly agreeing, the data reveals that consumers are motivated by the opportunity to explore new and previously unseen products, this novelty enhances the perception of exclusivity, making consumers feel that they own something truly special. This shows that handcrafted products must not only be unique in their inherent characteristics but also offer fresh and innovative designs to sustain consumer interest.

Overall, the results collectively underscore the uniqueness imperative as a powerful driver of consumer engagement and purchasing behavior in the handicraft sector. For artisans and producers, this presents a strategic opportunity to differentiate their offerings by emphasizing exclusivity, innovation, and authenticity. By leveraging the appeal of uniqueness, businesses can cater to consumers' desire for self-expression and individuality, ultimately fostering stronger emotional connections and loyalty. Furthermore, marketing strategies that highlight the distinctiveness of handicrafts—such as storytelling about their origin, limited editions, or cultural significance—can amplify their value in the eyes of consumers. This approach not only meets the demands of a uniqueness-driven market but also enhances the sustainability and profitability of the handicraft industry.

DISCUSSION

The swift advancement of technology will facilitate the intelligent evolution of the craft industry and promote the rapid progression of the 4.0 craft sector. Innovative and creative local crafts are seen as very marketable objects or products for both local and international consumers. The digital manufacturing capabilities of 3D printing generate chances for customization and innovation that can transform the application of traditional crafts. The design and creation of "Neo-Craft" with advanced technology aims not to supplant craftspeople, but to assist enterprises in enhancing their creative processes and streamlining their manufacturing workflows. 3D printing significantly influences creative design, modeling, material utilization, production, and other aspects of craft design and production. This aligns with the contemporary characteristics of craft design, emphasizing application and personalization, and will serve as a crucial trajectory for the future advancement of the craft industry.

CONCLUSION

The handicraft industry shows significant potential to be an essential sector in the development of rural tourism (Hosseinnia & Shoja .2017; Albert, 2023; Li, et al., 2024). Modern and contemporary handicrafts express and emphasize the inner emotions and personal experiences of both the designer and the consumer, irrespective of form, color, material, or style. The incorporation of 3D printing into the handicraft market is an opportunity to merge the efficiency of contemporary technology with the uniqueness of artisanal creation, resulting in a hybrid approach that could enhance sustainability.

The utilization of 3D printing in handicrafts may mitigate the deterioration of expert workmanship and the rising expenses linked to conventional techniques. The incorporation of 3D printing technology into "Neo-Craft" production is an intriguing possibility for sustaining local craftsmanship while addressing the constraints of contemporary manufacturing. Nonetheless, the expense attached with high-quality 3D printers and components might be prohibitive for small-scale artisans, particularly in rural regions. Initiatives should be implemented to enhance the affordability and accessibility of this technology. By integrating tradition with innovation, Sabah handicrafts could persist in flourishing within the modern era, presenting symbols of Sabah's ethnic identity. This research enhances the understanding of traditional crafts' design and growth, providing perceptions to improve the marketability of other cultural products encountering analogous obstacles in contemporary times.

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REFERENCES

- Albert WY Leow. (2023). Sustaining and preserving Malaysia's local handicraft industry. *International Journal of Tourism and Hotel Management*, 5(3): 28-32.
- Alfoddy, S. (2007). *Neo Craft: modernity and the crafts*. Press of the Nova Scotia College of Art and Design, Halifax, N.S.
- Ariffin, W.J.W.; Shahfiq, S.; Ahmad, F.; Ibrahim, A.& Ghazalli, F.S. (2023). Handicraft innovations: A strategic approach to preserving intangible cultural heritage of Malaysia. *ISVS eJournal*, 10(7), 137-146
- Fabeil, N.F.; Pazim, K.H.; Marzuki, K.M. & Langgat, J. (2014). The orientation of handicraft entrepreneurs in Sabah: Their personality characteristics and motivations (*Orientasi Usahawan Kraftangan di Sabah: Ciri Personaliti dan Motivasi*). 2nd ASEAN Entrepreneurship Conference, Penang, Malaysia.
- Hosseinnia, E.& Shoja, B. (2017). The role of handicrafts in the sustainable development of rural tourism with an emphasis on indigenous knowledge. *Int. J. Geogr. Geol.* 2017, 6, 1–7.
- Kamaruddin, Z. (2020) Sustainability of Malay Traditional Craft and Craftmanship as Cultural Heritage in Kuala Kangsar, Perak, Malaysia. *Journal of Architecture, Planning and Construction Management*, 3(1). Retrieved from <https://journals.iium.edu.my/kaed/index.php/japcm/article/view/523>

- Li, Y., Muhammad A. I., & Asrul A. (2024). How has rural tourism influenced the sustainable development of traditional villages? A systematic literature review, *Heliyon*, Vol 10, Issue 4, 2024, e25627, <https://doi.org/10.1016/j.heliyon.2024.e25627>
- Mhd Hanif, M. S., Sabran, M. K., & Azizan, H. A. (2024). Harmonising traditional and technology: 3D printing's role in modernising Rebab Melayu. *Jurai Sembah*, 5(1), 23-36. <https://doi.org/10.37134/juraisembah.vol5.1.3.2024>
- Nayak, J. K., & Bhalla, N. (2016), "Factors motivating visitors for attending handicraft exhibitions: special reference to Uttarakhand, India", *Tourism Management Perspectives*, Vol. 20, October, pp. 238-245, available at: <https://doi.org/10.1016/j.tmp.2016.10.001>
- Nguyen, H. T. (2024). Promoting sustainable consumption and circular economy: the intention of Vietnamese youth consumers to purchase products made from recycled plastics, *Chinese Journal of Population, Resources and Environment*, Vol 22 (2), 194-203, <https://doi.org/10.1016/j.cjpre.2024.06.011>
- Olawumi, M., Oladapo, B., Ikumapayi & O, Akinyoola, J. (2023). Waste to wonder to explore possibilities with recycled materials in 3D printing, *Science of The Total Environment*, Vol 905,167109, <https://doi.org/10.1016/j.scitotenv.2023.167109>.
- Otjela, L., & Folcut. O. (2019). Use of Recyclable Materials in the Interior Design. *European Journal of Economics and Business Studies*. 5. 79. 10.26417/ejes.v5i2.p79-100
- Oza Megha S., (2019). "Study of Handicraft Industry Strategies and Its Implications in Marketing", *International Journal of Research and Analytical Reviews*, vol. 6 (2), pp. 874-877
- Pasricha, A., & Greeninger, R. (2018). Exploration of 3D printing to create zero-waste sustainable fashion notions and jewelry. *Fash Text* 5 30. <https://doi.org/10.1186/s40691-018-0152-2>
- Roy, S., & Mohapatra, S. (2023). Exploring the culture–creativity–innovation triad in the handicraft industry using an interpretive approach. *Journal of Business Research*, 156, 113460. <https://doi.org/10.1016/j.jbusres.2022.113460>
- Ye, X. (2020). Protection and Development of Traditional Arts and Crafts Based on Computer 3D Animation Modeling Technology," 2020 IEEE 3rd International Conference of Safe Production and Informatization (IICSPI), Chongqing City, China, 2020, pp. 680-683, doi:10.1109/IICSPI51290.2020.9332349
- Zhang G. (2023). RETRACTED: Research on the application of 3D reconstruction technology in traditional handicraft design. *International Journal of Electrical Engineering & Education*. 2023;60(1_suppl):2541-2552. doi:[10.1177/00207209211005274](https://doi.org/10.1177/00207209211005274)