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RESEARCH ARTICLE

The Double-Edged Sword: Drawbacks of Modern Technology in the Research and Development of Yazhou Pottery

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ABSTRACT

The integration of modern digital technologies into traditional crafts is widely promoted as a pathway to cultural revitalization and sustainable development, yet such interventions may generate unintended socio-cultural consequences. Focusing on Yazhou pottery, a nationally recognized form of intangible cultural heritage in Guizhou Province, China, this study examines the drawbacks of modern technology in the research and development of traditional ceramic crafts. Using a qualitative design, we conducted semi-structured interviews with ten stakeholders, including master potters, young practitioners, and design or technology professionals. Interview data were analyzed through grounded theory supported by NVivo, and descriptive counts were retained as minimal quantitative supplements to enhance transparency. Findings show that while computer-aided design, ceramic 3D printing, and AI-assisted design can improve efficiency and expand creative possibilities, they also introduce substantial challenges. Key concerns include high costs and uneven access to equipment, steep learning curves, technical instability in digital fabrication, intergenerational tensions in training and decision-making, and threats to cultural authenticity and handcraft identity. Participants cautioned that reliance on digital templates may encourage standardization and cultural homogenization if not carefully governed. The study concludes that technological integration in Yazhou pottery is a double-edged sword and argues for prudent integration, positioning technology as an assistive rather than substitutive tool guided by community participation, cultural integrity, and sustainable skill transmission. By foregrounding practitioners' perspectives, this research contributes a practice-based understanding of how heritage crafts can navigate technological change while preserving cultural diversity and human creativity.

Contribution/Originality: This study contributes to literature on craft digitization. This study uses new methodology: grounded-theory. This study originates formula: "prudent integration." This study is one of few investigating authenticity fears. The paper contributes the first logical analysis. The paper's primary contribution is finding that mechanization homogenizes. This study documents learning barriers.

1. Introduction

In recent years, the integration of modern digital technologies into traditional crafts has been widely promoted as a strategy for cultural revitalization, economic development, and sustainable heritage preservation (El Agamy AbdelKader, 2023; Ma & colleagues, 2022). Technologies such as computer-aided design (CAD), ceramic 3D printing, and artificial intelligence (AI) have been increasingly applied in craft production to enhance efficiency, expand formal possibilities, and respond to market demand (Chen et al., 2019; Lin et al., 2023). Within policy discourses on intangible cultural heritage (ICH), technological innovation is often framed as a necessary pathway to prevent the marginalization of traditional crafts in contemporary society (El Agamy AbdelKader, 2023; Ma & Wang, 2022).

However, this technology-centered narrative has been increasingly questioned by scholars in heritage studies, design ethics, and cultural sustainability. While digital tools may offer tangible economic and technical benefits, their uncritical adoption risks undermining the cultural authenticity, embodied knowledge, and social relationships that constitute the core values of traditional craftsmanship (Prażmowska, 2020). UNESCO (2025) warns that unbalanced data, algorithmic personalization, and platform logics may deepen inequalities and foster cultural monocultures, thereby eroding cultural rights and community agency. These concerns are consistent with ethical guidance on digital platform governance proposed by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST, 2019).

Yazhou pottery, a regional ceramic tradition from Guizhou Province, China, provides a compelling case through which to examine these tensions. Recognized as national intangible cultural heritage, Yazhou pottery is deeply embedded in local ecological knowledge, family-based transmission, and tacit hand skills. Recent efforts to modernize its production—through digital modeling, 3D printing, and automated processes—have generated both optimism and controversy among artisans, designers, and cultural managers. Yet existing academic research on Yazhou pottery has largely focused on historical documentation and cultural symbolism, with limited empirical attention to how practitioners experience the challenges and drawbacks of technological integration (Zhang, 2021). Figure 1 presents representative Yazhou pottery artworks, illustrating its distinctive forms and surface ornamentation as a basis for the subsequent discussion on technological intervention and cultural authenticity.

More broadly, although a growing body of literature discusses the role of digital technology in heritage preservation, empirical studies that critically examine the negative consequences of technological intervention from the perspective of craft practitioners remain scarce (Skublewska-Paszkowska et al., 2022). Many studies emphasize technological empowerment, while underexamining issues such as learning barriers, economic inequality, loss of handcraft identity, and intergenerational conflict (Sustainability Directory, 2025). As a result, there is a lack of grounded understanding of

how modern technology reshapes craft practices at the community level (Skublewska-Paszkowska et al., 2022; Tan et al., 2021).

Figure1: Yazhou pottery artwork

Source: From Guizhou Furniture Association, artist Zhang Su

To address this gap, the present study investigates the following research question: What are the drawbacks of employing modern technology in the research and development of Yazhou pottery? Drawing on semi-structured interviews with artisans and design professionals, and guided by grounded theory methodology, this study systematically identifies the technical, economic, and socio-cultural challenges associated with technological adoption. By foregrounding the lived experiences of practitioners, this study advances a more nuanced and critical understanding of the role of technology in heritage crafts, and proposes a framework for prudent integration that prioritizes cultural integrity, community agency, and sustainable innovation (Tan et al., 2021).

2. Method

2.1. Study Design and Participant Recruitment

We adopted a qualitative approach using semi-structured interviews to capture nuanced experiences and perceptions. Ten participants were recruited during a three-week field visit to Guizhou in early 2024. Purposeful sampling ensured representation of different roles in the craft ecosystem: two nationally or provincially recognized master potters, two young potters or apprentices (20–30 years old), and five design and technology specialists (including a ceramics design professor and product designers who collaborate with craft cooperatives).

Participants were identified through local cultural heritage associations and personal networks. All interviews were conducted in Mandarin Chinese with the assistance of a research assistant who is fluent in the local dialect (see Table 1).

Table 1: Basic information of interview respondents

Role	Name	Gender	Age	Title	Background
Designer 1	Kang Yang	female	38	adjunct professor	Ceramic design major
Designer 2	Yuan Keyun	female	42	adjunct professor	Art design major
Designer 3	Zhao Dan	female	36	lecturer	Landscape design major
Designer 4	Yao Xiaoxi	female	35	lecturer	Art design major
Designer 5	Luo Bing	male	37	lecturer	Head of ceramic company
Potter 1	Jiang Zekuo	male	38	Senior ceramicist	Yazhou pottery expert
Potter 2	Liu Yuanhai	male	40	Senior ceramicist	Yazhou pottery expert
Potter 3	Shi Guojia	male	22	Ordinary potter	Worked for 3 years
Potter 4	Li Weiqing	female	21	Ordinary potter	Worked for 3 years
Potter 5	Chang Demin	male	41	Ordinary potter	Head of ceramic company

2.2. Interview Protocol

The interview guide balanced questions about traditional techniques, perceived needs for modern technology, attitudes toward digital tools and visions of future integration. Questions probed what participants considered representative of Yazhou techniques, which modern technologies were most urgently needed, how digital design and 3D printing were perceived, and how technology might affect production efficiency, product quality and cultural value. We also asked about irreplaceable aspects of the craft and challenges faced during technological adaptation. The flexible format allowed interviewers to follow up on emergent topics, such as market pressures or training concerns.

2.3. Ethical Considerations

This study received approval from the relevant institutional ethics committee. All participants received an information sheet outlining the study's purpose and provided written informed consent, including permission to audio and video record the sessions. To protect confidentiality, interview transcripts were anonymized; participants are referenced by codes (e.g., P1–P5 for potters and D1–D5 for designers). When quoting, we avoided revealing personal details beyond their role and general experience level. As interviews were conducted in Chinese, quotations used in this paper were translated into English and back translated to ensure fidelity to the original meaning.

2.4. Data Analysis

Interviews were transcribed verbatim and imported into NVivo 12 for analysis. Following grounded theory principles, we conducted open coding by examining each line of text and assigning initial codes. Many codes corresponded to questions in the interview guide (e.g., "representative technique," "technology need," "integration effect"). To enhance reliability, two researchers independently coded the first two

transcripts and reconciled differences through discussion; one researcher then coded the remaining transcripts, with periodic cross checking (see Table 2).

Table 2: Three-level coding table

Level 2 coding	Level 3 coding
A1 representative process	Wheel turning, molding, pasting and carving are the traditional representative techniques of Yazhou pottery
	The *"ice crack"* and *"green/blue glaze"* in the glazing technology have local characteristics
	In the firing process, *"panning ash"* and *"dragon kiln"* reflect the traditional flavor
A2 Irreplaceability of process	Wheel throwing and carving are difficult to be replaced by modern technology, because they involve personality, technique and artistic creation
	The expression of personality in glazing cannot be standardized and copied
	Traditional craftsmanship contains *"emotion"*, *"aesthetics"* and *"creative unpredictability"*
B1 Modern technology types	CAD modeling, 3D printing, AI design assistance, digitalization
	Rolling molding, parameter controlled equipment, glaze ratio automation
B2 Improve efficiency and quality	Cost reduction, production efficiency greatly improved
	The yield rate is improved and the degree of standardization is improved
	The appearance of the product is more smooth and the structure is more standardized
B3 Expansion of creative expression	AI and 3D design can help to quickly achieve complex or innovative shapes
	To make up for the lack of imagination in manual work
	Try to expand the source of creative materials and enrich the color and configuration
C1 The value of the integration of tradition and modernity	Preserve the core of culture and enhance market acceptance
	Create the dual value of *"culture + function"*
	Give equal weight to innovation and inheritance
C2 Technical adaptability issues	Craftsmanship technology is difficult to learn, and the software threshold is high
	Cross-generation, cross-job training (such as Rhino, Maya, 3D Max)
	It takes time to adapt and integrate tools
C3 The influence on traditional shapes and patterns	Most think it has little impact, or is even more refined and easier to innovate
	A small number of people worry about *"losing the sense of handcraft"* and *"uniformity"*
	The mode of *"machine shaping + manual refinement"* is advocated
D1 Process distribution trend	Most believe that *"increased modern technology"* is the trend (e.g., 70% modern /30% traditional)
	A minority think *"half and half"* is reasonable (depending on the use: art vs. daily use)
	Universities, industries and inheritors need to work together to promote integrated development
D2 Use site differentiation	Daily necessities are suitable for standardized mass production (led by modern technology)
	High value-added art or custom items need to retain the core of traditional craftsmanship
	Market demand determines the allocation of emphasis

During axial coding we grouped codes into higher-level categories and explored relationships among them. Themes such as "technical challenges," "economic costs" and "heritage preservation" emerged across participants. NVivo's query functions helped identify frequently occurring concepts (e.g., "efficiency," "learning curve," "mass production") and allowed comparison between potters and designers. We used modelling tools to visualise how causal conditions (e.g., low efficiency, technological pressures), contextual factors (e.g., governmental support for intangible heritage), and intervening variables (e.g., attitudes toward technology) influence strategies for integrating modern tools, drawing on situational models from grounded theory.

As a minimal quantitative supplement, this study reports descriptive counts derived directly from the interview design and coding process, without introducing additional data collection or statistical analysis. The interview sample comprised ten participants, including five potters and five design or technology specialists, which enabled basic role-based comparison across stakeholder groups. Within the potter group, both senior master potters and younger practitioners were represented, while the designer group included academic and industry-oriented professionals. In addition, grounded-theory analysis generated eight thematic areas, each encompassing both perceived benefits and drawbacks of modern technology integration, providing a structured basis for cross-theme comparison. Finally, participants' forward-looking assessments of process allocation (e.g., an anticipated shift toward "70% modern / 30% traditional" production) are retained as indicative experiential judgments rather than as statistically measured distributions.

3. Results

3.1. Technical Barriers and Learning Curves

Across the sample, participants noted steep learning curves associated with digital design software, 3D printing and advanced firing equipment. Young potters (P3, P4) expressed excitement about digital tools but admitted struggling to master computer-aided design programs. One apprentice remarked that their studio *"basically uses traditional techniques, and learning new technologies is a big challenge,"* highlighting the gap between hand skills and digital literacy. Master potters (P1, P2) recounted limited exposure to 3D modelling and emphasised that tactile feedback from working clay could not be fully replaced by computer screens.

Literature on digital heritage corroborates these experiences. Virtual-reality systems used for capturing ICH require high-end hardware and real-time rendering, presenting obvious challenges (Skublewska-Paszkowska et al., 2022). Motion-capture methods for digitizing dance or craft can be limited by marker occlusion, requiring time-consuming post-processing (Skublewska-Paszkowska et al., 2022). For potters in small rural communities, acquiring and maintaining such equipment is prohibitive. Even when accessible, users must adapt to new work flows and calibrate parameters; 3D printing studies reveal that improper extrusion speeds cause defects or nozzle blockages (Lin et al., 2023). These technical barriers demand sustained training and support, which were lacking in the study context.

3.2. Economic Burdens and Resource Constraints

The author learned this by visiting. For small family workshops, investing in a single ceramic 3D printer, let alone a cluster of machines, is a substantial financial outlay.From visiting the Yazhou pottery base, that the studio's investment in 3D printers required external funding and was justified only because they also served as educational tools. The small studios say voiced concern that maintenance expenses, software licensing fees and the need for specialized technicians could outweigh potential benefits (see Figure 2).

Figure 2: Yazhou pottery comparison between small studio and typical studio

Source: Compiled by the author

These concerns are echoed in trade publications, which note that ceramic 3D printing is slower than other additive methods and requires complex post processing; the machines and materials are expensive, and larger prints are challenging without defects (Skublewska-Paszkowska et al., 2022). Additionally, achieving high density, flaw-free ceramic pieces remains difficult (Iftekar et al., 2023). The cost of constant experimentation, misprints and machine downtime falls disproportionately on artisans rather than on industrial firms. Modern technologies are often designed for mass manufacturing; when scaled down to artisanal contexts they demand resources that local communities may lack.

3.3. Risks to Authenticity and Cultural Homogenization

Perhaps the most emotionally charged theme concerned potential threats to the authenticity and uniqueness of Yazhou pottery. Master potters stressed that certain hand processes coil building, burnishing, free-hand carving and unpredictable glazes constitute the essence of the craft. Respondents worried that reliance on digital templates and machine generated patterns could lead to homogenized designs and loss of individual expression. As P1 commented, *"If we use machines too much, everything will look the same; it will no longer be Yazhou pottery."* Young artisans (P3–P5) echoed this sentiment, fearing that mass production could diminish the spiritual connection they felt with the clay.

The literature underscores these fears. UNESCO's AI and Culture report warns that algorithmic personalization and unbalanced training data can reinforce bias and foster monocultures (Iftekar et al., 2023). It notes that over reliance on AI risks eroding human creativity and cognitive capacities (UNESCO, 2025). Sustainability scholars argue that automation and mass production reduce demand for handcrafted items, threatening artisans' livelihoods and eroding unique craft skills (Sustainability Directory, 2025). The same sources caution that the pursuit of efficiency may homogenize cultural expressions and undermine diversity (Ma & Wang, 2022; Prażmowska, 2020). Interviewees mirrored these concerns, highlighting that the unpredictability of glaze flows, a hallmark of Yazhou pottery, could not be captured by digital simulations.

3.4. Intergenerational Tensions and Skills Transmission

Modern technology also affected dynamics between older masters and younger practitioners. While designers and younger potters generally welcomed new tools as avenues for experimentation and career development, elder craftsmen were more sceptical. P2 noted that *"traditional things are lost and Yazhou pottery is not Yazhou pottery, but new technology can be used as a supplement,"* revealing a pragmatic yet cautious stance. Several masters expressed frustration that young people sometimes preferred digital shortcuts over mastering hand skills. Conversely, younger participants felt that elders undervalued the efficiency gains and new aesthetic possibilities offered by technology. These tensions complicated the transmission of tacit knowledge, as both groups grappled with how to teach and learn in a hybrid environment.

Interviewees worried about sustaining training when modern tools changed work flows. Traditional apprenticeship models emphasize immersion, observation and tactile feedback; integrating digital design demands new pedagogies and equipment. Moreover, advanced tools could exacerbate generational divides if access and digital literacy are uneven. Scholars note that mass production and automation can erode artisanal knowledge and discourage new entrants to craft communities (Sustainability Directory, 2025). Unless balanced with deliberate mentoring and capacity building, technological adoption might accelerate the fading of skilled handcraft.

3.5. Limitations Inherent to Digital Fabrication

Beyond socio-cultural concerns, participants recognized intrinsic limitations of digital fabrication technologies. Potters and designers noted that 3D printing prone to technical failures. They described how clay extruders often clogged, printed layers collapsed under their own weight and surface textures lacked the subtle variations achieved by

hand. Achieving the desired thickness and curvature for vessels proved challenging without subsequent hand trimming. Additionally, the size of printable objects was constrained by the machine's build volume; larger works required segmenting and reassembly, which increased labor.

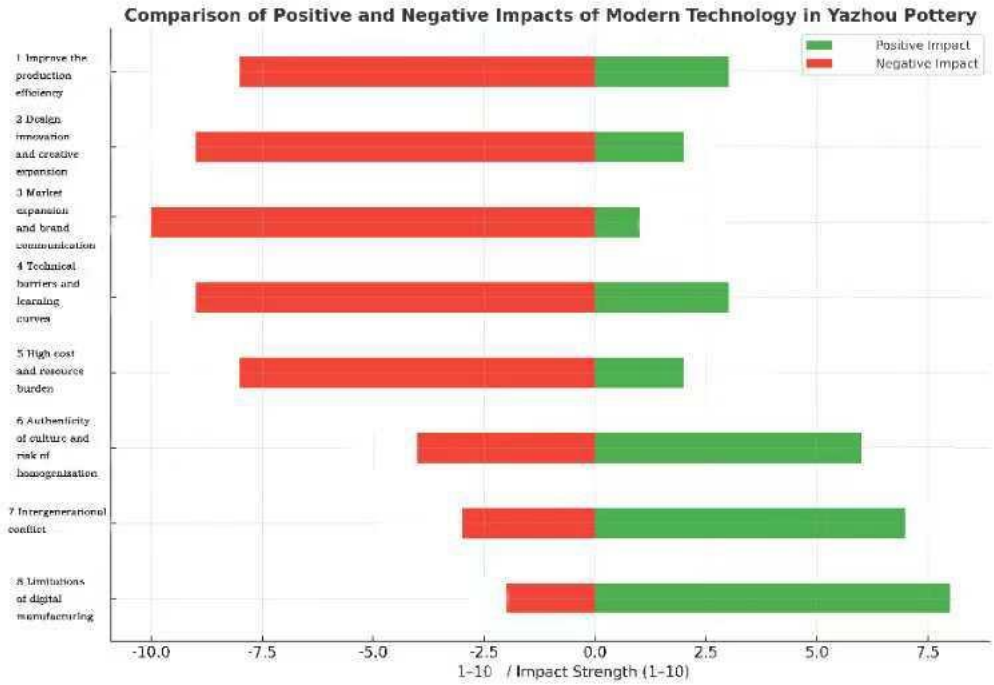
Empirical studies corroborate these observations. Researchers have demonstrated that the quality of ceramic 3D prints hinges on precisely controlling extrusion speed and inlet velocity: too fast causes defects or outlet blockage, whereas too slow leads to poor bonding and breakpoints (Lin et al., 2023). Simulation models struggle to accurately reflect real-world flow because clay enters the nozzle through slender pipes and experiences collisions and backflow (Lin et al., 2023). Even advanced reviews emphasize that producing high density, flaw free ceramic pieces and accelerating production remain significant challenges (Iftekar et al., 2023). Practical guides for ceramic 3D printing list high material cost, slow printing speed, complex post-processing and size limitations among the main drawbacks (Ly et al., 2022). These inherent limitations temper the enthusiasm of practitioners, who see technology as a supplementary tool rather than a panacea (see Table 3) (see Figure 3).

Table 3: Summary of the positive and negative impacts of the eight subjects

Number	Subject	Positive Impact Description	Negative Impact Description
1	Improve the production efficiency	The interviewees concluded that 3D printing and CAD could reduce mold-making time, save energy, and boost production.	However, the equipment is complex, the parameters are difficult to adjust, the error rate is high, and the operation is difficult in small workshops.
2	Design innovation and creative expansion	AI and digital modeling can help generate new shapes and patterns, inspiring creativity.	Some designs are templated by machines, and personal style and "feel" are weakened.
3	Market expansion and brand communication	Modern technology helps to promote e-commerce, digital exhibitions and international branding.	Technical products are easy to be confused with other regional processes, which weakens regional identification.
4	Technical barriers and learning curves	The younger generation is more receptive to digital tools, which facilitates cross-border learning.	It is difficult for veteran craftsmen to learn CAD and printer operation.
5	High cost and resource burden	Large bases or government projects can improve competitiveness through technology.	Small workshops cannot afford the cost of equipment, software and maintenance.
6	Authenticity of culture and risk of homogenization	Digitization helps to preserve pattern data and establish archives.	Mechanized production makes the works *"one and the same"*, losing the spirit and the mark of handwork.
7	Intergenerational conflict	Young people can use technology to reignite their interest and expand their	The old artists believe that young people rely on machines and ignore basic skills, resulting in a

		learning.	generation gap.
8	Limitations of digital manufacturing	Technology can assist in prototyping or teaching demonstrations.	3D-printed clay frequently clogs nozzles, causes layer collapse, has limited dimensions, and poor texture.

Figure3: Comparison of positive and negative impacts of modern technology in Yazhou pottery (Compiled by the author)



4. Discussion

4.1. Rethinking technological innovation in heritage crafts

The findings of this study challenge the prevailing assumption that technological innovation inherently benefits traditional craft development. While participants acknowledged improvements in efficiency and design flexibility, they consistently emphasized that these gains come at the cost of increased technical complexity, cultural dilution, and uneven access to resources. This aligns with broader critiques that unreflective technological adoption can generate structural barriers and unintended socio-cultural consequences (Maisiri et al., 2021; UNESCO, 2025). From an ethics and governance perspective, these risks further support the need for culturally sensitive, rights-respecting approaches to digital platforms and technological integration (World Commission on the Ethics of Scientific Knowledge and Technology [COMEST], 2019; UNESCO, 2025).

In the context of Yazhou pottery, technological tools were widely perceived as assistive rather than substitutive. Core hand processes—such as wheel throwing, freehand carving, and glaze application—were regarded as irreplaceable carriers of cultural meaning and personal expression. This finding is consistent with scholarship emphasizing that craft knowledge is embodied and socially situated, and that learning and meaning-making cannot be reduced to technical replication alone (Tan et al., 2021). It also resonates with discussions on how technology may affect traditional craft skills

and techniques when efficiency-driven logics dominate production choices (Sustainability Directory, 2025).

4.2. Technological inequality and economic sustainability

A key contribution of this study lies in revealing how technological adoption may exacerbate inequality within craft communities. Larger studios and government-supported bases were better positioned to absorb the high costs of equipment, software, and maintenance, while small family workshops faced substantial financial risk. Such disparities echo barriers reported in research on sustainable adoption of Industry 4.0, where resource constraints and capability gaps inhibit equitable implementation (Maisiri et al., 2021). In addition, practical guidance on ceramic 3D printing emphasizes that equipment, materials, and post-processing demands can be costly and technically burdensome for smaller-scale users (Ly et al., 2022).

These findings suggest that without institutional support, cooperative models, or shared infrastructure, technological modernization may undermine rather than enhance the long-term viability of heritage crafts. Economic sustainability, therefore, should not be evaluated solely in terms of productivity, but also in relation to equity, accessibility, and community resilience—particularly when innovation is linked to broader organizational and policy environments (Nguyen et al., 2025).

4.3. Cultural authenticity and the risk of homogenization

Concerns over authenticity and homogenization emerged as the most emotionally salient theme among participants. Artisans feared that reliance on digital templates and machine-generated forms could result in standardized aesthetics that weaken regional identity. Such concerns are compatible with UNESCO's warning that algorithmic systems and data-driven cultural production can foster cultural monocultures and undermine diversity if not governed responsibly (UNESCO, 2025). Related legal scholarship further cautions that digitization and platform circulation can intensify risks of cultural misappropriation and weaken community control over heritage knowledge (Prażmowska, 2020). Reflections on craft skills also suggest that heavy technological mediation may reduce demand for—and transmission of—handcraft competencies, thereby altering the social fabric of craft communities (Sustainability Directory, 2025).

Importantly, participants did not reject technology outright. Instead, they advocated hybrid modes of production—such as "machine shaping plus manual refinement"—that preserve the visual and tactile qualities of handcraft while selectively benefiting from technological assistance. This position is supported by technical reviews indicating that ceramic 3D printing remains constrained by process sensitivity, defect risks, post-processing complexity, and challenges in achieving stable, high-quality outputs (Chen et al., 2019; Iftekar et al., 2023; Lin et al., 2023).

4.4. Implications for heritage governance and education

The intergenerational tensions observed in this study highlight the need for new pedagogical and governance strategies. Traditional apprenticeship models must evolve to include digital literacy, while digital training should remain anchored in cultural values and tacit knowledge (Tan et al., 2021). Universities, cultural institutions, and heritage authorities can play a mediating role by facilitating participatory innovation,

cross-generational learning, and ethical guidelines for digital intervention (World Commission on the Ethics of Scientific Knowledge and Technology, 2019; UNESCO, 2025).

5. Conclusion

The integration of modern technology into Yazhou pottery production represents a double-edged sword, underscoring the necessity of prudent integration rather than uncritical technological adoption. This study demonstrates that while digital tools such as CAD, ceramic 3D printing, and AI-assisted design can enhance production efficiency and stimulate new aesthetic possibilities, they also introduce substantial challenges, including technical complexity, high economic costs, intergenerational tensions, and the inherent limitations of current fabrication systems. These findings highlight that technological advancement in heritage crafts is not a purely technical issue but a deeply socio-cultural process embedded in local practices, values, and power relations.

By foregrounding the perspectives of artisans and designers, this research reveals how excessive reliance on digital technologies may weaken embodied knowledge, diminish handcraft identity, and contribute to cultural homogenization if not carefully governed. At the same time, participants' advocacy for hybrid production modes suggests that technology can play a constructive role when positioned as an assistive tool that complements rather than replaces traditional craftsmanship. This supports a community-led approach to innovation in which cultural integrity, equity of access, and skill transmission are prioritized alongside efficiency gains.

Situated within broader debates on digital heritage and sustainable craft development, this study contributes a critical, practice-based understanding of technology's ambivalent role in traditional crafts. Future efforts to modernize Yazhou pottery and similar heritage practices should therefore balance innovation with preservation, ensuring that cultural diversity, human creativity, and community agency remain central to technological change.

Ethics Approval and Consent to Participate

This study received ethical approval from the relevant Research Ethics Committee of Universiti Teknologi MARA (UiTM), and all procedures involving human participants were conducted in strict accordance with the university's ethical guidelines.

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Conflict of Interest

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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