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Artificial intelligence-based innovation of batik motif design in Indonesia and Malaysia: a cross-cultural collaborative approach for sustainable cultural preservation

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ABSTRACT

This study documents and analyses a practice-based collaboration in which Indonesian and Malaysian designers used generative artificial intelligence (AI) to synthesise shared batik motifs, and examines how faithfully the source motifs survived that process. Adopting a practice-based / research through-design approach, the study brought together practitioner researchers from three Indonesian and two Malaysian institutions. Six iconic source motifs *Parang*, *Truntum*, and *Mega Mendung* (Indonesia) and *Bunga Kerak Nasi, Pucuk Rebung*, and the Tiger Orchid motif (Malaysia) were combined through a structured prompt protocol using two text to image platforms (Midjourney and Bing Image Creator) and refined in Adobe Illustrator. The resulting nine motif outputs and two garment visualisations were assessed through iconographic visual analysis and collaborative expert appraisal across four dimensions: cultural fidelity, cultural distortion, design innovation, and design-stage resource efficiency. The analysis shows that generative AI was effective for ideation and cross tradition synthesis but unreliable for fidelity. Only the discrete, radially repeatable Truntum was reproduced with high fidelity, whereas the directional, field-organising geometric motifs *Parang* and *Pucuk Rebung* were the least faithful; because this weakness appeared in motifs from both traditions, it reflects a structural limitation of the technology rather than a national bias. Colour was the least controllable parameter, and culturally faithful results emerged only through a human corrective stage, positioning AI as a partner in human AI co-production. The study contributes a replicable cross-national workflow, an analytical mapping of motif fidelity, and a reframing of the two traditions from contested ownership toward shared authorship.

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1. Introduction

Batik is among the most recognisable textile arts of Southeast Asia and holds deep cultural significance in both Indonesia and Malaysia, where it functions at once as everyday dress, ceremonial attire, and a marker of identity. This shared heritage is also, however, a source of friction: the two countries hold overlapping claims to the origins of particular motifs, and these claims have periodically intensified into public disputes over cultural ownership [1]. Such tensions form part of a wider pattern of bilateral disagreement, and they frame the problem this study addresses: how two closely related traditions might engage their shared visual heritage cooperatively rather than competitively [2]. Scholarship on *batik* has concentrated heavily on

the documentation, meaning, and contemporary development of its motifs. Recent work shows that batik ornamentation continues to evolve in response to consumer preference and fashion, moving toward more minimalist and hybridised forms while retaining cultural reference points [3]. At the same time, the sector faces persistent structural challenges, including limited design innovation, debates over cultural appropriation, and well-documented problems of labour exploitation in small-scale production [4]. This body of work establishes batik as a living, adaptive tradition, yet it has paid little attention to how emerging digital and generative tools might support motif innovation while safeguarding cultural identity. A second strand of relevant research concerns sustainability. Textile and broader manufacturing scholarship argues that production systems frequently prioritise short-term output over ecological limits and proposes operational frameworks, lean, green, and related approaches for reducing environmental impact [5]–[11]. This literature is, however, largely generic to manufacturing and rarely engages the specific material practices of batik or, more importantly, the design stage that precedes production, where digital methods might reduce wasteful physical prototyping [12]. The sustainability of *batik* is thus typically framed as a production problem rather than a design problem. A third strand examines the Indonesia–Malaysia relationship itself. Studies of the cultural ownership controversies and of bilateral disputes more broadly approach the relationship chiefly through legal, territorial, and political lenses, while work on conflict and peacebuilding emphasises its psychological and social dimensions [1], [2], [13]. What this strand does not offer is a constructive, practice-based model in which the contested traditions are brought together through shared creative work rather than adjudicated as competing claims.

Cutting across these strands is the rapid emergence of generative artificial intelligence, and text-to-image systems in particular, as practical instruments for visual design [14], [15]. These tools can produce complex patterns rapidly and let designers explore many variations at low cost, yet their application to intangible cultural-heritage motifs and to cross-national motif co-creation remains largely unexamined [16]–[18]. This study is organised around the relationship between three constructs: generative AI as a design instrument; *batik* design innovation as the creative outcome it enables; and sustainability in two distinct and bounded senses: the cultural sustainability of heritage motifs (their continued use and recognisable transmission) and the ecological efficiency achievable specifically at the design stage. The study treats AI as a potential means toward *batik* innovation and asks under what conditions that innovation can serve cultural continuity without eroding the visual identity of the source traditions, deliberately separating this cultural question from the narrower, design stage question of resource efficiency. Taken together, these three strands have developed largely in isolation from one another, and none has examined generative AI as a practical instrument for collaborative motif creation that deliberately brings the two traditions together rather than treating them as competing claims. In parallel, the fast-growing literature on AI in design has rarely engaged with intangible cultural-heritage motifs or with cross-national co-creation, leaving open the question of whether and how text-to-image systems can support culturally grounded batik innovation without eroding the visual identity of the source traditions. This study addresses that gap by documenting and analysing a practice-based collaboration in which Indonesian and Malaysian designers used generative AI to synthesise shared *batik* motifs.

Accordingly, this study pursues three objectives. First, it documents and analyses a practice-based process of generating collaborative Indonesia–Malaysia *batik* motifs using text-to-image platforms (Midjourney and Bing Image Creator) together with vector editing (Adobe Illustrator). Second, it examines the extent to which the AI-generated outputs preserve or distort the visual characteristics of the selected source motifs *Parang, Truntum*, and *Mega Mendung* from Indonesia, and *Bunga Kerak Nasi, Pucuk Rebung,* and the Tiger Orchid motif from Malaysia. Third, it evaluates the cultural fidelity and design quality of the outputs through the collaborative appraisal of the practitioner-researchers. These objectives are guided by the following research questions: (RQ1) How can generative AI text-to-image tools be used to synthesise collaborative *batik* motifs that integrate Indonesian and Malaysian visual vocabularies? (RQ2) To what extent do the resulting outputs retain the visual character of each source motif, and where does cultural distortion occur? (RQ3) How do the practitioner-researchers assess the outputs in terms of cultural fidelity and design innovation? This study contributes a documented, replicable workflow for AI-assisted cross-national *batik* co-creation

and an analytical mapping of how individual source motifs are manifested or transformed in the generated outputs. Its novelty lies less in any claim that AI can "resolve" historical tensions than in demonstrating a concrete, reflective practice through which two contested traditions can be approached as collaborators rather than rivals. The study deliberately frames its claims modestly: it treats ecological sustainability and conflict mitigation as potential implications to be examined rather than as proven outcomes.

2. Method

2.1. Research design

This study adopts a practice-based / research-through-design approach, in which new knowledge is generated through, and reflected upon from, the act of designing itself [19]. This paradigm was chosen because the inquiry centres on a creative artefact: collaborative Indonesia–Malaysia *batik* motifs produced by a team of expert practitioners, and because the research questions concern how such artefacts can be generated with AI and to what extent they preserve the source traditions (RQ1–RQ2). Rather than testing a hypothesis under controlled conditions, the study documents an intentional design process and subjects its outputs to systematic visual analysis and expert appraisal; the overall workflow is summarised in Fig. 1. The work is the outcome of a cross-national academic collaboration between Universitas Pendidikan Indonesia (UPI), the Institute of Jakarta Arts (IKJ), and Trisakti University (Usakti) in Indonesia, and University Malaysia Kelantan (UMK) and Universiti Teknologi MARA (UiTM), Machang, in Malaysia.

2.2. Units of analysis and motif selection

Two units of analysis are distinguished: (a) the individual source motif, treated as the reference against which fidelity is judged; and (b) the composite AI-generated output, treated as the primary research artefact. Six source motifs were selected: *Parang, Truntum*, and *Mega Mendung* (Indonesia) and *Bunga Kerak Nasi, Pucuk Rebung*, and the Tiger Orchid motif (Malaysia). These motifs were chosen because [author to specify the selection criteria, e.g. they are among the most iconic and visually recognisable motifs of each tradition and together represent both geometric and organic visual families], enabling a balanced cross-cultural synthesis.

2.3. Materials and tools

Motif generation used two text-to-image platforms, Midjourney [author to specify version, e.g. v6] and Bing Image Creator, with subsequent refinement of line work and colour in Adobe Illustrator. [Author to state any fixed generation parameters used e.g. aspect ratio, stylisation or quality settings; if none were fixed, state that default settings were used.]

2.4. Design-generation procedure

A structured prompt protocol was followed in which each prompt specified, in a fixed sequence: (i) subject and thematic scope; (ii) the enumerated source motifs; (iii) stylistic constraints (line-art treatment and stroke weight); (iv) compositional rules (symmetry or repeat and motif separation); (v) chromatic and surface constraints; and (vi) technical resolution. The full prompts used for each output are reproduced in Appendix A. The analysis reported here is based on the nine motif outputs organised into three sets (Fig. 2, Fig 3, and Fig. 4) together with two garment visualisations (Fig. 5). Selection of outputs for refinement was based on [author to specify the selection criteria, e.g. legibility of both traditions, balanced composition, and suitability for textile printing]. The exact number of candidate images generated and the number of regeneration iterations per motif were not systematically recorded; this is acknowledged as a limitation (see Conclusion).

2.5. Expert appraisal and analysis

The generated outputs were analysed using iconographic visual analysis, in which each composite was compared against the documented visual characteristics of its constituent source motifs to determine which motifs were manifested, which were dominant, and where the recognisable visual character of a source motif was preserved or distorted. This analysis was complemented by collaborative expert appraisal drawing on the complementary expertise of the four authoring practitioner-researchers, whose domains are summarised in Table 1. The appraisal was organised around four dimensions: (1) cultural fidelity the degree to which an

output retains the recognisable visual identity of each source motif; (2) cultural distortion points at which a source motif loses its identity or hybridises unrecognisably; (3) design innovation the novelty of the synthesis relative to conventional *batik* treatments; and (4) design-stage resource efficiency the reduction of physical prototyping cycles afforded by digital iteration, reported as the study's bounded interpretation of "sustainability" at the design stage (no claim is made regarding the ecological sustainability of downstream textile production).

Table 1. Author expertise and contribution to the study.

Author (affiliation)	Domain of expertise	Contribution
Ahamad Tarmizi Azizan (UMK)	Generative AI; idea generation	Led AI prompt engineering, output generation, and garment visualisation
Adlien Fadlia (IKJ)	Fashion and textile design	Appraisal of design quality and fashion application
Farid Abdullah (UPI)	*Batik* and fine arts	Appraisal of *batik* iconography and cultural fidelity
Aneeza Mohd Adnan (UiTM)	Textile design (Malaysia)	Appraisal of Malaysian motif fidelity and textile suitability

Note: authors to confirm the operational contribution of each co-author.

2.6. Trustworthiness

Because this is a qualitative, practice-based study, rigour is established through trustworthiness rather than experimental control. Reproducibility is supported by full disclosure of the prompts, platforms, and parameters (Appendix A), allowing the workflow to be repeated. Credibility is supported by appraisal across four complementary areas of expertise spanning both national traditions. Confirmability is supported by an explicit audit trail from source motif to prompt to output. The authors note one boundary on credibility: the appraisal was conducted by the practitioner-researchers themselves; independent external validation is identified as a limitation and an avenue for future work (see Conclusion). The preparation of the manuscript involved the use of AI tools as disclosed in the Note; their role is reported transparently as part of the documented design procedure. As can be seen in Fig. 1.

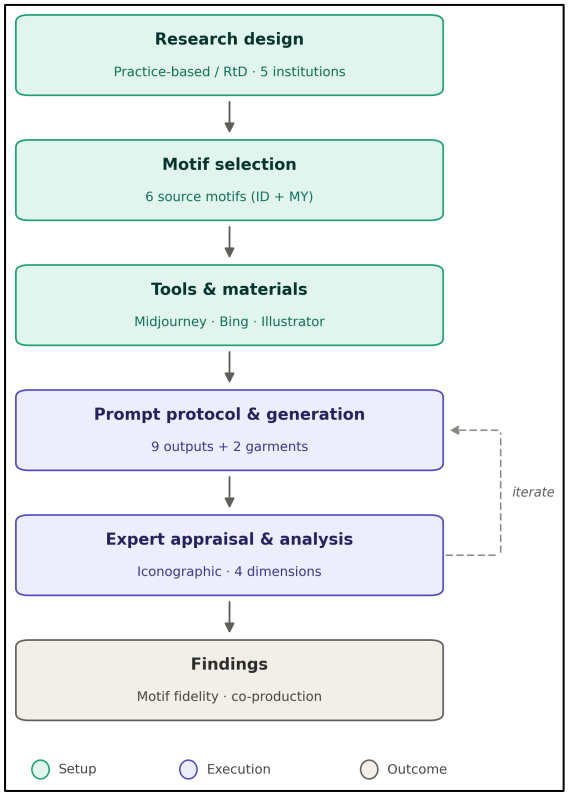

Fig. 1. The practice-based research workflow for Indonesia Malaysia *batik* motif co-creation.

3. Results and Discussion

3.1. Overview of generated outputs

The design process produced nine *batik* motif outputs, organised into three composite sets (Fig. 2, Fig. 3, and Fig. 4), together with two garment visualisations demonstrating textile application (Fig. 5). The full prompts used to generate each set are reproduced in Appendix A; this section reports the iconographic analysis and collaborative expert appraisal of the outputs against the four dimensions defined in Section 2.5.

3.2. Manifestation and fidelity of source motifs

Across the nine outputs, the six source motifs were retained with markedly uneven fidelity (Table 2). The clearest and most consistent pattern concerns motif geometry: the two strongly geometric, field-governing motifs, the directional diagonals of *Parang* (Indonesia) and the triangular framing of *Pucuk Rebung* (Malaysia), were the least faithfully reproduced, appearing only intermittently and almost never as organising elements. Because this weakness spans both national traditions rather than one, it indicates a structural limitation of the text-to-image models in handling directional and framing geometry, not a bias toward either country's visual vocabulary [20]. By contrast, only one motif the clustered star flowers of *Truntum* was reproduced with high fidelity, recurring across the sets and dominating the symmetrical composition of Fig. 3. The remaining motifs occupied an intermediate position: the rice-crust flowers of *Bunga Kerak Nasi* were prominent yet generalised, reading more as non-specific blossoms than as the precise source motif, while the cloud scrolls of *Mega Mendung* and the *Tiger Orchid* form were recognisable only in places before being absorbed into the surrounding floral field. The overall picture for RQ2 is therefore that high-fidelity preservation was the exception rather than the rule: most source motifs were diluted or transformed, and only a discrete, radially repeatable unit (*Truntum*) survived intact. This finding tempers any assumption that generative AI straightforwardly preserves the visual identity of heritage motifs. Set 1 (Fig. 2; indigo ground, asymmetrical). Floral forms dominate the composition, but their fidelity is partial: the prominent pale flowers read as generalised blossoms rather than a precise *Bunga Kerak Nasi*, and the Indonesian geometric motifs *Parang* in particular are largely absent. The output reads as a floral field with Malaysian floral emphasis rather than a balanced two-tradition synthesis. Set 2 (Fig. 3; warm-brown *sogan*, symmetrical). *Truntum* is dominant and clearly legible within a kaleidoscopic symmetry, and the warm-brown palette is the closest of the three sets to the classical *sogan* register. This set best demonstrates high-fidelity reproduction of a single source motif. Set 3 (Fig. 4; mixed palette). This set achieves the most even co-presence of multiple vocabularies stars, florals, and cloud scrolls together and is the closest to genuine synthesis; however, as the motifs intermingle, their individual identities blur, illustrating a trade-off between integration and fidelity.

Table 2. Fidelity of source-motif manifestation in the AI-generated outputs (appraisal of the practitioner researchers; see Section 2.5).

Source motif (tradition)	Documented visual character	Fidelity	Notes on manifestation / distortion
Parang (Indonesia)	Diagonal wavy blades; directional geometry	Low	Diagonal directional structure rarely reproduced; field reorganised around organic forms
Truntum (Indonesia)	Clustered radial star-flowers	High	Strong recognisability; dominant in Figure 3
Mega Mendung (Indonesia)	Layered cloud scrolls	Partial	Recognisable in places; often absorbed into the floral field
Bunga Kerak Nasi (Malaysia)	Rice-crust flower; rounded clusters	Partial	Present and prominent but generalised; reads as non-specific floral
Pucuk Rebung (Malaysia)	Triangular bamboo-shoot framing	Low	Triangular framing geometry rarely reproduced
Tiger Orchid (Malaysia)	Orchid flower form	Partial	Merges with generic florals; distinct orchid identity weak

3.3. Chromatic outcomes

The recurrent use of *sogan* (warm brown) and maroon was a deliberate choice intended to anchor the outputs in the classical Central Javanese *batik* palette, in which *sogan* brown is the signature ground; maroon extends this earth-tone register and supports cross-cultural neutrality between the two traditions. A notable finding concerns the gap between specified and realised colour: although the prompts specified a rich-maroon background, the realised palettes diverged indigo (Fig. 2), brown (Fig. 3), and teal/indigo (Fig. 4) with the specified maroon realised consistently only in the garment application (Fig. 5). This divergence is itself a result: colour proved to be among the parameters least reliably controlled through prompting, a constraint that designers must correct manually in vector editing.

3.4. Application to garments

The refined motifs were applied to long-sleeved *batik* garments for men and women (Fig. 5), realised in a maroon *sogan* palette. This step demonstrates the feasibility of translating AI-generated motifs into wearable textile products and confirms that the workflow extends beyond pattern generation to applied design. As can be seen in Table 3.

Table 3. Overview of the nine generated outputs and the garment application.

Set (Figure)	Palette specified	Palette realised	Composition	Dominant motif(s)	Fidelity summary
1 (Fig. 2)	rich maroon	indigo	asymmetrical	*Bunga Kerak Nasi* (generalised floral)	Partial; *Parang* largely absent
2 (Fig. 3)	rich maroon	warm brown (*sogan*)	symmetrical	*Truntum*	High fidelity for *Truntum*
3 (Fig. 4)	muted pastel / indigo	mixed (teal–indigo)	seamless repeat	mixed (stars, florals, clouds)	Even co-presence; identities blur
Garment (Fig. 5)	—	maroon *sogan*	asymmetrical (applied)	applied composite	Demonstrates textile application

Fig. 2 shows AI-generated *batik* motif outputs, Set 1 (indigo ground, asymmetrical composition).

Fig. 2. AI-generated *batik* motif outputs, Set 1 (indigo ground, asymmetrical composition).

Fig. 3 shows AI-generated *batik* motif outputs, Set 2 (warm-brown *sogan*, symmetrical composition).

Fig. 3. AI-generated *batik* motif outputs, Set 2 (warm-brown *sogan*, symmetrical composition).

Fig. 4 shows AI-generated *batik* motif outputs, Set 3 (mixed palette, seamless repeat).

Fig. 4. AI-generated batik motif outputs, Set 3 (mixed palette, seamless repeat).

Fig. 5 shows application of the AI-generated motifs to long-sleeved *batik* garments for men and women (maroon *sogan*)

Fig. 5. Application of the AI-generated motifs to long-sleeved batik garments for men and women (maroon *sogan*).

3.5. Discussion

1) Why some motifs survive and others dissolve

The central finding that *Truntum* alone was reproduced with high fidelity while *Parang* and *Pucuk Rebung* were the weakest can be interpreted through the structural difference between the motifs. *Truntum* is a discrete, radially symmetric unit that tiles naturally across a field; this modular, repeatable character aligns closely with how current text-to-image systems construct seamless textile patterns, in which a local element is sampled and distributed. *Parang* and *Pucuk Rebung*, by contrast, encode directional and field-organising geometry: *Parang*'s meaning resides in the continuous diagonal flow that governs the whole cloth, and *Pucuk Rebung*'s in a triangular framing logic. These are global, long-range structural orders rather than local repeatable units, and they are precisely the kind of organising geometry that diffusion-based generators reproduce least reliably [16], [20]. That this weakness appears in both an Indonesian and a Malaysian motif is significant: it locates the limitation in the generative technology's handling of directional geometry, not in any bias of the model toward one national tradition. *Bunga Kerak Nasi*'s intermediate, generalised manifestation fits the same logic the model retained its rounded floral mass but discarded the specific rice-crust articulation that distinguishes it.

2) Implications for cultural fidelity and heritage preservation

Because high-fidelity reproduction proved to be the exception rather than the rule, the results qualify a common assumption that generative AI can straightforwardly preserve heritage motifs. What the models did, more accurately, was generalise the source vocabularies toward a pan-decorative floral idiom, with the semantically loaded geometric motifs most at risk of erasure a consequential outcome, given that *Parang* is among the most culturally weighted Indonesian motifs. The implication is that culturally faithful AI *batik* is not an automatic output of prompting but a conditional achievement requiring a human corrective stage; in this study, the vector-editing phase in Adobe Illustrator was where designers could restore what the generator had diluted. Heritage preservation, in this workflow, is therefore best understood as human–AI co-production rather than AI substitution [18].

3) Implications for design innovation

The genuine contribution of AI in this study lay in ideation and synthesis rather than in fidelity. The tools rapidly produced cross-tradition combinations that would be laborious to draft by hand, and Set 3 (Fig. 4) in particular demonstrated novel co-presences of Javanese and Malaysian vocabularies that constitute real design innovation [15], [21]. The findings thus support a measured claim: generative AI expands the creative search space of batik design and accelerates iteration, even as it introduces a fidelity trade-off that the designer must manage [16]. Innovation and fidelity emerged here as competing, not complementary, objectives most visible in Set 3, where the closest approach to synthesis coincided with the greatest blurring of individual motif identities.

4) Implications for Indonesia–Malaysia collaboration

Framing the two traditions as collaborators rather than rivals is, in itself, the study's principal cultural contribution. The collaborative process produced artefacts that neither tradition could claim exclusively, shifting the relationship from contested ownership toward shared authorship [21]. The symmetry of the AI's behaviour reinforces this framing: because the generator's strengths (discrete florals) and weaknesses (directional geometry) applied equally to motifs from both countries, the tool engaged both vocabularies with the same impartiality, offering a neutral common ground for co-creation. This is a modest, symbolic contribution to easing cultural rivalry through joint practice not a mechanism of political conflict resolution.

5) Bounded claims on sustainability and conflict

Two claims require explicit calibration. First, the study's contribution to sustainability is confined to the design stage: digital iteration reduced the number of physical prototyping cycles required before reaching a print-ready motif [12]. The study makes no claim about the ecological sustainability of downstream *batik* production, which remains governed by wax, dye, and water use and lies outside this study's scope. Second, the contribution to cultural tension is reflective and symbolic demonstrating a model of collaborative authorship rather than a demonstrated resolution of the historical disputes between the two countries. Stated within these bounds, the findings are defensible; stated more broadly, they would exceed the evidence.

4. Conclusion

This study set out to document and analyse a practice-based collaboration in which Indonesian and Malaysian designers used generative AI text-to-image tools, refined in vector software, to synthesise shared *batik* motifs, and to examine how faithfully the source motifs survived that process (RQ1–RQ2). The analysis of nine motif outputs and two garment visualisations yields a clear but qualified answer. Generative AI proved an effective instrument for ideation and cross-tradition synthesis but an unreliable one for fidelity: of the six source motifs, only the discrete, radially repeatable *Truntum* was reproduced with high fidelity, whereas the two directional, field-organising geometric motifs *Parang* (Indonesia) and *Pucuk Rebung* (Malaysia) were the least faithfully rendered, and the remaining motifs were generalised toward a non-specific floral idiom. Because this geometric weakness appeared equally in motifs from both countries, it reflects a structural limitation of the generative technology rather than a bias toward either tradition. Colour proved the least controllable parameter through prompting and required manual correction. High-fidelity preservation was therefore the exception rather than the rule, and culturally faithful results emerged only through a human corrective stage positioning AI in this workflow as a partner in human AI co-production rather than a substitute for the designer. On this basis the study makes four concrete contributions. First, it provides a documented, replicable workflow for AI-assisted cross-national batik co-creation, with the full prompt protocol reproduced in Appendix A. Second, it offers an analytical mapping (Table 2) of how individual heritage motifs are manifested or transformed by generative AI, contributing empirical evidence on motif fidelity that remains scarce in the literature. Third, it identifies a specific and transferable finding that current text-to-image models reproduce discrete, repeatable units far more reliably than directional or field-organising geometry of relevance to heritage motif generation beyond *batik*. Fourth, it reframes

the Indonesia–Malaysia *batik* relationship from one of contested ownership toward shared authorship through joint creative practice.

The study's claims are deliberately bounded by its limitations. The appraisal of the outputs was conducted by the practitioner-researchers themselves; while their complementary expertise in AI, *batik*, and textile design provides internal cross-checking, the study does not include validation by experts external to the author team. The corpus is small and was produced by a single collaborative team, which constrains generalisability. The generation process was not exhaustively logged, so the total number of candidate images and the number of iterations per motif are not reported. The fidelity assessment is qualitative and iconographic rather than based on a quantified rubric. Finally, as set out in the discussion, the study's contribution to sustainability is confined to the reduction of physical prototyping at the design stage and makes no claim regarding the ecological footprint of downstream batik production, and its contribution to easing cultural tension is symbolic rather than a demonstrated resolution of historical disputes. These limitations define a clear agenda for future research. Independent validation of AI-generated motifs by *batik* and textile experts external to the design team would strengthen claims of cultural fidelity, ideally supported by a quantified assessment rubric and a broader expert panel. Technical work is needed on generation pipelines that better preserve directional and field-organising geometry, so that semantically weighted motifs such as *Parang* are not eroded. The workflow could be extended to other contested or complementary motif pairs, within the region and beyond, and a life-cycle assessment of AI-assisted batik production would test whether design-stage efficiencies translate into genuine ecological benefit. Pursued along these lines, AI-assisted co-creation offers a constructive and shared path for the continued evolution of *batik* in Indonesia and Malaysia.

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Declarations

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