

AI AND DIGITAL BUDDHIST SCULPTURE: PERFORMANCE, ROLES, AND TECHNOLOGY ACCEPTANCE BASED ON THE TAM FRAMEWORK IN THE CONTEXT OF THAI ARTS AND CULTURE

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ABSTRACT

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The objectives of this study are to: 1) assess the efficiency of an AI system created for producing digital Buddhist sculptures; 2) investigate the role of AI in the context of Thai art and culture; and 3) assess the acceptance of AI technology by digital sculpture designers. A total of 180 undergraduate students (novice designers) and 30 professional digital Buddha sculptors were surveyed using quantitative methods. In addition to the surveys, a qualitative assessment was performed through interviews with nine subject matter experts. The results of the efficiency assessment indicate that the AI system has high accuracy, produces designs quickly, and provides support for designers in creating complex designs. The findings in relation to the Technology Acceptance Model (TAM) demonstrate that perceived usefulness and perceived ease of use will have a significant impact on users' intention to adopt the technology. Results of the qualitative assessments demonstrate that the AI system is able to create sculptures that adhere to Thai Buddhist artistic codes and symbols to some degree; however, expert guidance is necessary to maintain the spiritual significance and semantic meaning of the artwork. Thus, when applying AI in Thai art and culture, it is recommended that collaborations be established between the developers of AI systems and experts in the field of Thai art and culture to ensure the integrity of the culture. AI should be utilized as a complementary tool to augment designers' creative process in a sustainable manner.

Keywords: Artificial Intelligence; digital Buddhist sculpture; Thai Buddhist art; cultural semiotics; cultural design; Technology Acceptance Model

1. INTRODUCTION

Thai Buddhist art serves as a vital part of the cultural heritage of Thailand. In addition to serving as an educational tool for Buddhism, the artwork serves as a spiritual anchor and a representation of Thailand's faith (Kobbun, 2018). As much as Buddhist sculpture is aesthetically pleasing, the sculpture is an artistic representation of the Thai people's reverence and spiritual connection to their ancestors and community beliefs that have been passed down through generations (Srisontisuk & Norkaew, 2024).

Over the last decade, there has been rapid growth in digital technology and AI used in both the arts and the field of cultural preservation. Digital technology and AI have become essential tools in multiple ways, including the use of 3D modeling, restoring artifacts, and sharing artistic knowledge effectively (Bonacchi & Krzyzanska, 2019; Harisanty et al., 2024; Aneklap et al., 2025). However, the use of AI for digital heritage preservation in Thailand is a contested area, as the majority of the Thai people believe Buddha statues to be "sacred objects"; therefore, when utilizing AI, the question becomes whether the creation of digital reproductions diminishes the authenticity and spiritual value of these sacred objects (Singhasonthi & Purisuttamo, 2020). Many critics and sculptors have expressed concerns that the use of algorithms to model digital reproductions may reduce the moral and spiritual integrity of the original work. Additionally, without a comprehensive dataset that includes cultural nuances specific to Thailand, AI is likely to make incorrect assumptions about important iconographic elements, including facial expressions, hair, and posture (Thitasabho et al., 2023).

There are also many ethical implications associated with generating digital Buddhist sculptures via AI, which include questions concerning the rights of artisans, the protection of copyright, the proper use of religious imagery, and the impact on the community of believers. Therefore, there is a need to extend research beyond purely technical aspects to address the culturally responsive and ethically acceptable deployment of AI in Buddhist digital heritage preservation (Saijai, 2018). Thus, an examination of AI-generated digital Buddhist sculptures must go beyond assessing the technological capabilities and must evaluate the cultural and ethical implications, as well as technology acceptance among the stakeholders. To this end, this study utilizes Davis's Technology Acceptance Model (TAM) (Alshammari & Al-Mamary, 2025), while incorporating digital heritage theory (Bonacchi & Krzyzanska, 2019), cultural semiotics (Jinshun & Jun, 2021), and AI ethics (Floridi & Cows, 2022). Ultimately, the aim of this study is to develop a holistic approach that balances digital innovation with the cultural values and traditional practices of Buddhism, while providing direction for future technology adoption.

Therefore, the three main objectives of this article are: 1) to assess the performance of the AI system developed for generating digital reproductions of Buddhist sculptures, 2) to understand the potential role of AI in creating digital reproductions of Buddhist sculptures in the cultural context of Thailand, and 3) to determine how digital sculpture designers perceive and accept the technology used in generating digital reproductions of Buddhist sculptures. Insights gained from this study are expected to provide a foundation for developing AI systems that respect the cultural heritage and identity of the Thai people.

2. LITERATURE REVIEW

2.1 AI technology and digital cultural heritage conservation

AI uses large amounts of data and processes this information using algorithms and techniques similar to how human neural networks function; as such, it allows for the creation of entirely new works of art that are able to mimic the thinking and creativity of a human artist (Arochasiri, 2024). An example of AI being utilized to create completely new art forms is the use of Generative Adversarial Networks (GANs) (Elgammal et al., 2018), which allow AI to create new art based on extensive databases of images. Consequently, AI is being used to repair damaged sections of ancient artifacts. The results obtained from using AI indicate a high level of similarity to the original artifact, thereby decreasing the risk of human error and increasing the accuracy of the conservation process (Stanco et al., 2011). These properties are congruent with the principles of accuracy and integrity in digital heritage.

The Theory of Authenticity by Jones (2010) posits that the authenticity of an art piece is dependent upon more than just the physical nature of the work itself, but also its history, the materials used, the artist's and spiritual intent, and its relationship to a specific culture and religion. As such, the theory indicates that while AI may be capable of modeling or restoring ancient artifacts, maintaining their authentic historical and cultural significance will require the involvement of local cultural experts and members of the cultural community, which is consistent with the principle of community engagement in digital heritage.

Currently, there are many institutions around the world employing AI in the preservation, documentation, and interdisciplinary presentation of cultural heritage. These approaches aim to make cultural

heritage more accessible, to preserve local knowledge in modern society, and to enhance the collaborative aspects of cultural heritage management (Harisanty et al., 2024).

Thai art and culture are increasingly utilizing AI for conserving and disseminating cultural heritage. This is largely because AI has the capability to process and analyze physical representations of art and generate highly accurate and realistic three-dimensional models (Aneklap et al., 2025). Consequently, AI has become a key tool in the field of art restoration, digital archiving, and Thai art to the general public. Additionally, AI provides Thai communities with access to Thai art in the form of 3D models, virtual media, and digital environments (Jitta, 2020). However, the use of AI must be balanced with human agency so that the spiritual values of the artwork and its original identity are maintained. Similarly, the risk of misinterpreting Thai culture must be effectively managed. Digital Heritage Theory (Bonacchi & Krzyzanska, 2019) emphasizes that cultural accuracy, authenticity, symbolic meaning, community engagement, and shared ownership are all essential elements of digital heritage. Misunderstanding the social and traditional contexts of Thai culture could result in misrepresentations of Thai its symbolic identity and other important cultural issues (Aneklap et al., 2025).

2.2 Thai Buddhist art and symbolic meaning

Thai Buddhist art is a reflection of cultural expression in terms of the aesthetic dimensions of Buddhism and its teachings. The primary function of this type of art is to serve as a means of expressing the Dhamma, or teachings of Buddhism, to the population of Thailand. As such, Thai Buddhist art functions as a conduit for passing on the moral and spiritual ideals of the people of Thailand. Thus, Thai Buddhist art is more than just a representation of a specific aesthetic style. It is also a symbolic representation that significantly contributes to shaping the lives of the people of Thailand in terms of their beliefs and virtues (Thitasabho et al., 2023).

When viewed through a symbolic lens, Thai Buddhist art can be seen as a form of cultural expression that conveys the meanings of the teachings of Buddhism. Through artistic representations, Thai Buddhist art conveys the teachings of Buddhism to its followers using a system of conventions that represent the Characteristics of the Great Man (Mahapurusa Laksana), postures (Mudra), facial expressions, robes, and other stylistic characteristics of various artisan schools. Each of these conventions represents a cultural code that communicates the story of the Buddha and his teachings to followers (Singhasonthi & Purisuttamo, 2020). As a result, the creation of Buddhist art can be described as an interpretative process of assigning meanings to signs of Buddhism that have been transmitted from one generation to another.

Through the lens of Yuri Lotman's Cultural Semiotics in 1988 (Jinshun & Jun, 2021), Buddhist art can be conceptualized as a semiotic system that holds meaning only in relation to the semiotics, or the cultural and historical context of the community of artists who create the art and the community of viewers who receive the messages of the art. In this sense, the meanings of the symbols in Buddhist art are not fixed but evolve over time as social and cultural contexts change. For example, the fluidity and elegance of Sukhothai Buddhist art convey the ideas of peace and tranquility while reflecting the ideals of Dhamma and beauty, whereas the stylization of Rattanakosin Buddhist art reflects the sacred nature of rituals, the prosperity of the king, and the grandeur of the royal court.

Thai Buddhist art continues to perform an important role in defining the collective identity of the Buddhist religious community in Thailand as the creative synthesis of the values, customs, and artistic taste of each generation of Thai Buddhists. This view of the role of art in defining cultural identity is consistent with the idea that art is a vehicle for creating and maintaining culture (Sakhong et al., 2024). Additionally, Thai Buddhist art provides a mechanism for fostering mindfulness, meditation, and wisdom that enable viewers to contemplate the virtues of the Buddha and incorporate the principles of Dhamma into their daily lives (Yanthong, 2024). The meanings associated with Thai Buddhist art continue to be relevant today, leading to the development of contemporary Buddhist art, including digital media such as 3D graphics, animation, and digital sculpture (Phetsamai, 2025). Contemporary Buddhist art, however, presents the opportunity to expand the reach of the teachings of Buddhism to a broader audience and requires the preservation of symbolic accuracy, sanctity, and cultural context that define the semiotic system of Thai Buddhist art (Inkong, 2023). Ultimately, whether in traditional or digital formats, all forms of Buddhist art should be created with a deep understanding of the wisdom, religiosity, and cultural sensitivity of the people whose teachings the art seeks to express, as the misuse of technology to express the teachings of Buddhism may distort or provide culturally unacceptable representations of the principles of Buddhism.

2.3 Challenges of Buddhist art in the era of AI

The use of AI for classification and symbolic interpretation of Buddhist art does enhance the accuracy of those tasks, but the use of AI for analyzing Buddhist art has its limitations. There are many limitations in the way that AI analyzes Buddhist art, which relate to both academic accuracy and cultural sensitivity, as well as ethical concerns regarding the treatment of Buddhist art. For example, the potential of AI to compromise the

cultural identity and religious significance of Buddhist art should be carefully considered when making decisions about the use of AI systems. To provide some background on the issues identified in the application of AI to Buddhist art, the researchers have summarized several key areas of concern as follows:

1) Data constraints: Because of the rarity and fragility of the source data used to train AI systems that analyze images of Buddhist sculptures, the potential threat exists for the systems to “learn” too much from small datasets and therefore to have difficulty interpreting the symbolism of Buddhist sculptures (a phenomenon known as overfitting). To address this issue, researchers need to incorporate ontologies or knowledge graphs associated with the religious and ritualistic context of Buddhist art into their training data (Xing et al., 2025).

2) Artistic and cultural integrity: The generation of new representations of Buddhist sculptures through the use of AI may create confusion between the simulated representation of an artifact based on physical and historical evidence, and the reconstruction of an artifact using AI algorithms (Liyanage et al., 2025). If the public begins to confuse AI-generated reconstructions of Buddha sculptures with actual sculptures created during the time period they represent, then the authenticity of the original sculptures will begin to lose meaning, and the religious intent of the sculptor may also become diluted.

3) Dilution of identity: The use of AI to analyze and create representations of Buddhist sculptures can result in the loss of the details required to understand the original artistic intent and the ritualistic context of the artwork (Thammawatsiri et al., 2024). Additionally, if the public views representations of Buddha sculptures created using AI as authentic representations of the Buddha, they may view them as having the same spiritual authority as the original sculptures. As a result, the use of AI to create representations of Buddha sculptures may be viewed as morally reprehensible due to the potential dilution of the spiritual authority of the original sculptures.

Thai Buddhist art includes a complex symbolic system that represents the identity and religious meaning of Thai Buddhism. As such, the use of AI to analyze or create representations of Thai Buddhist art carries the risk of misinterpretation if the system lacks a knowledge base (ontology) developed with the Thai cultural and religious context in mind. Furthermore, Thai Buddhist art is not simply an aesthetically pleasing representation of the Buddha; it is a representation of the Buddha that is embedded with religious intent and ritualistic context. These nuances of meaning cannot be understood by an AI system without guidance from a framework of data and descriptions that captures the spiritual values of Thai Buddhism. Therefore, developing AI systems for the analysis and creation of representations of Thai Buddhist sculptures requires an interdisciplinary approach that incorporates art history, cultural geography, religious rituals, and AI technology. Through this interdisciplinary approach, researchers can develop a system that understands and respects the religious and cultural context of Thai Buddhist art, accurately interprets its symbolic language, and preserves its identity in the digital environment.

2.4 AI ethics framework related to culture and religion

The contemporary development of AI is not just about developing a new technology, but is directly tied to the values we hold dear, our cultural norms, our religious beliefs, and our commitment to social responsibility, much like the unified ethical framework developed by Floridi and Cowls (2022). While this provides a general framework for developing all forms of AI, within the context of local culture and religion—where respect for local identity, local symbols, and beliefs is critical—the following key areas become more apparent:

1) Safety: In developing AI systems, safety means developing AI systems that protect users while respecting local values—specifically, protecting against the use of sacred images or objects in culturally inappropriate ways.

2) Fairness: AI must not have built-in ethnic, religious, or cultural biases, which would diminish the meaning of certain objects and practices to specific groups and communities.

3) Transparency: Developers must disclose how data are collected and processed so that end-users can verify the accuracy of the data and whether they reflect the local customs and traditions.

4) Accountability: Both developers and users of AI systems must be held accountable for the technical and ethical outcomes of these systems—especially when dealing with religious objects and artifacts.

5) Respect for human and cultural dignity: AI must not distort, desecrate, or mock religious symbols, and must reflect the cultural identity of the people and/or organizations that created them.

Additionally, Pansoni et al. (2023) identified three ethical risks associated with the use of AI in cultural heritage applications: data bias, ambiguity in determining accountability, and the potential for AI to alter the digital representation of cultural artifacts in a way that erodes their perceived value as religious objects. Research conducted by Jones (2010) emphasizes the importance of authenticity in terms of the cultural intent behind the artifact.

Research by Harisanty et al. (2024) has demonstrated that international cultural heritage institutions are now employing AI for the multi-disciplinary preservation, management, and distribution of cultural heritage; however, success depends on engaging with local communities to ensure that the intended meaning of the cultural artifacts is preserved and not misinterpreted over time due to the religious and cultural significance attached to them (Sherefetdinova, 2024). Thus, utilizing AI systems to develop, represent, or distribute information about sacred objects requires a high degree of cultural sensitivity and respect for cultural taboos and rituals. As such, any utilization of AI systems to study Thai Buddhist sculpture must be performed under an ethical framework that respects culture, religion, and the symbolic meaning of Thai art, thereby protecting the spiritual values and long-held identities of the people.

2.5 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), proposed in 1989 by Davis (Alshammari & Al-Mamary, 2025), has been one of the most widely used frameworks for understanding the determinants of information technology use by people. It asserts that the choice to use a technology is influenced by two major concepts: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), as these are directly linked to the attitude toward using the technology, which leads to actual use of the technology.

In reference to the design of digital Buddhist sculptures, TAM can be seen as an appropriate conceptual framework for studying the degree of acceptance of AI technology among Buddhist art designers and experts. For example, PU might represent the ability of the AI to accurately reproduce the symbols, style, and historical context of Buddhism, while PEOU refers to how easily and quickly the designer or expert could learn and utilize the AI technology. Therefore, TAM provides knowledge regarding the level of acceptance of technology in the arts and cultural area of study, which, as a discipline, must consider semantic sensitivity with extreme care due to its importance in research in this digital age.

3. MATERIALS AND METHODS

The present research uses a mixed methods research design (Timans et al., 2019). This type of research is particularly well-suited for examining the degree of acceptance of AI technology—a subject that involves both the technical aspects and social and cultural implications. This current study is attempting to combine the results of qualitative and quantitative studies to offer a complete understanding of the use of Artificial Intelligence in Thailand's Buddhist sculpture.

3.1 Materials

This research utilized a custom-made AI application as the primary experimental tool. The following tools were used for data collection:

1) Qualitative tool: Semi-structured interviews were used to obtain respondents' views on how AI can create 3D digital sculptures of the Buddha.

2) Quantitative tools: Two sets of 5-point Likert scales based on the format proposed by Taherdoost (2019) were created for efficiency assessment and acceptance measurement:

(1) Efficiency evaluation questionnaire: For evaluating 3D digital sculptures of the Buddha utilizing the traditional method of digital sculpting and AI-assisted sculpting methods. This questionnaire has 22 items divided into two areas: traditional digital method (11 items) and AI-assisted method (11 items).

(2) AI acceptance questionnaire: This questionnaire was developed from TAM and categorized into five factors: 1) Perceived Usefulness (PU); 2) Perceived Ease of Use (PEOU); 3) Satisfaction to Use; 4) Intention to Use; and 5) Actual Use.

All of the above-mentioned data collection instruments underwent a content validity verification process through three experts in measurement and evaluation, using the Index of Item-Objective Congruence (IOC) to determine if each item was clear, complete, and applicable to the intended population. All items with an IOC index equal to or higher than 0.50 were included in this study.

3.2 Methods

The study was granted approval by the Human Research Ethics Committee, Mahasarakham University, Thailand. Data were collected through a survey instrument from May to June 2025. All participants gave informed consent in writing with regard to the purposes of the study, confirming that their participation in this study is voluntary and they could withdraw at any time during the course of the study. Ethical standards relating to the use of human participants in research, as well as confidentiality, were adhered to. No identifiable or traceable personal information was included in any aspect of the study.

The AI system developed in this study is based on a depth estimation approach implemented within a Conditional Generative Adversarial Network (cGAN) framework. The generator employs a modified U-Net

architecture to translate 2D RGB images into corresponding depth maps and normal maps. Unlike diffusion-based models (e.g., Stable Diffusion) that generate images from text, this system focuses on reconstructing geometric structure by estimating depth information from input images.

The dataset used to train the proposed AI system consists of Thai Buddhist ornamental patterns categorized into seven primary groups, including Kanok, Krajung, Phum Khao Bin, Prajam Yam, Kab Pattern, Nok Kab, and Naga Khob motifs. The source materials were compiled from multiple origins, including hand-drawn line art, AI-assisted generated patterns (e.g., Stable Diffusion), and photographic documentation of real-world Buddhist sculptures, such as stucco work and wood carvings from temples and historical architecture across Thailand. These source materials were subsequently reconstructed into original 3D models and rendered into a dataset of 2,000 paired samples consisting of RGB images, depth maps, and normal maps for training purposes. A combined loss function, integrating L1 loss and gradient loss (via Sobel filtering), was employed to enhance edge preservation and maintain fine decorative details. This training strategy enables the system to generate structurally accurate and visually coherent 3D representations from 2D inputs. This process ensured consistency in geometric structure while preserving stylistic and ornamental diversity.

The generated depth maps are subsequently converted into 3D mesh models by mapping pixel coordinates into three-dimensional space, where depth values are normalized and scaled to define surface elevation. The resulting geometry is refined through noise reduction techniques (e.g., bilateral filtering) to preserve edge sharpness and ornamental details, which are critical in Thai Buddhist art (see Figure 1).

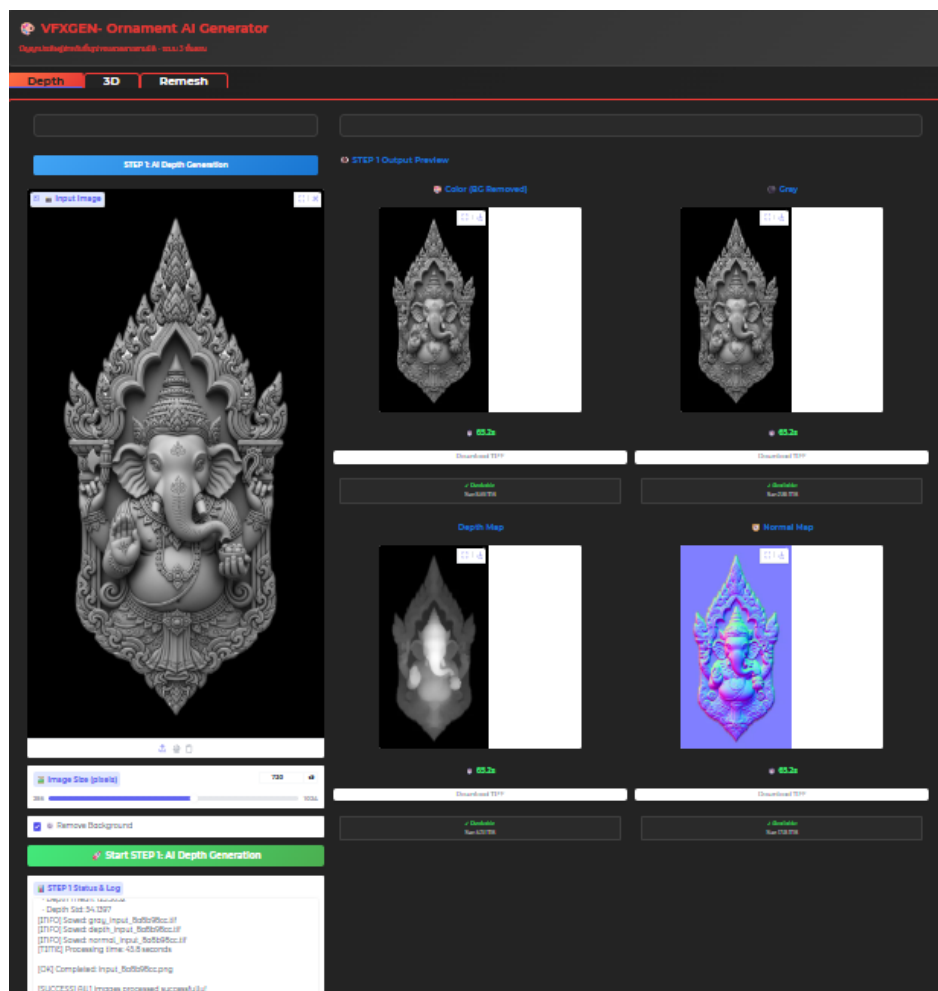


Figure 1: Workflow of the AI system for creating digital Buddhist sculptures.

To ensure practical usability, the system incorporates mesh optimization processes. Polygon reduction is performed using the Quadric Error Metrics (QEM) algorithm to minimize geometric complexity while preserving overall shape fidelity. In addition, an optional voxel-based quad remeshing process restructures the mesh into a quadrilateral topology, facilitating further digital sculpting and downstream applications such as 3D printing, AR, VR, and game engines (see Figure 2).

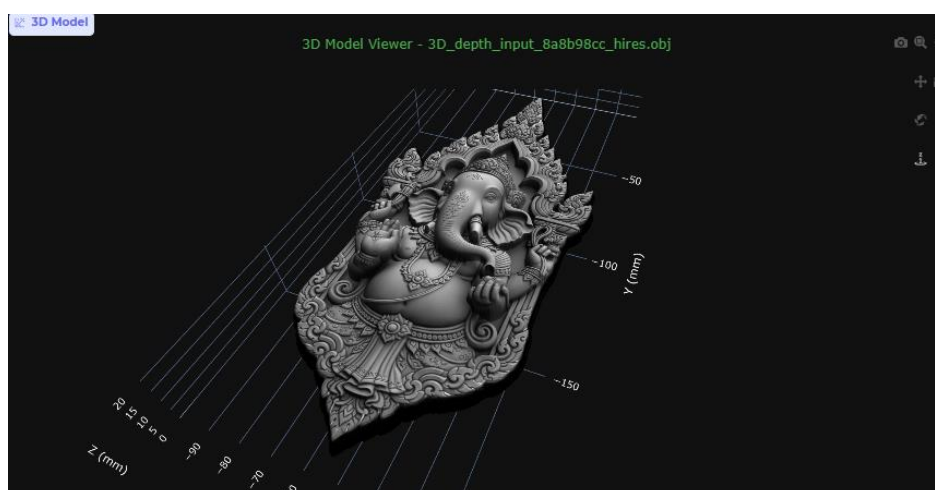


Figure 2: Digital Buddhist sculptures generated by the AI system.

The system is accessible via a web-based interface, allowing users to interact with the AI model directly through a standard web browser at <https://www.vfxgen.in.th/ai/ai-ornament>. Furthermore, the technical knowledge and implementation details underlying the AI system for 3D form generation have been publicly shared through a GitHub repository at <https://github.com/tistbroken/vfxgen>.

After developing an AI system to create digital versions of Buddhist sculptures, the AI system was presented to the sample population for trial use, and data were then collected on the basis of the following phases:

3.2.1 Efficiency testing of the developed AI system

In this phase, quantitative data were collected to determine whether or not there are differences in the time taken to create 3D forms of Buddhist objects by novice and professional designers when utilizing an existing digital system as opposed to a new AI-based system. Data were obtained from both novice and professional designers; data were analyzed via a t-test. Participants included two separate participant groups:

1) Novice Designers (n = 180): Undergraduate students selected through purposive sampling (Adeoye-Olatunde & Olenik, 2021), who were identified based on their previous experience in creating 3D digital sculptures of Buddhist art. Students were from the following departments:

(1) Department of Multimedia Technology, Rajamangala University of Technology Isan (n = 60).

(2) Department of Creative Media, Mahasarakham University (n = 60).

(3) Department of Multimedia and Animation Technology, Ubon Ratchathani Rajabhat University (n = 60).

2) Professional Designers (n = 30): Buddhist sculpture designers who were selected through Snowball sampling (Parker et al., 2019), which is a method used to gain access to specific, difficult-to-access professional practitioners.

3.2.2 Investigating the role of AI in Thai art and cultural context

In this study phase, a qualitative research methodology was adopted through conducting in-depth interviews to gather data from the nine key informants, categorized by three different expert groups as follows: Group 1-Thai Buddhist Art Experts (n = 3); Group 2-AI Development Experts (n = 3); Group 3-Digital 3D Sculpture Experts (n = 3). Using purposive sampling (Adeoye-Olatunde & Olenik, 2021) the participants were identified.

The qualitative data collected were then analyzed using thematic analysis as described by Braun and Clarke (2019) and incorporating the interpretive cultural approach of Clifford Geertz (Susen, 2024). This was utilized to clarify the AI's role in terms of its technical dimensions, symbolic meaning dimensions, and culturally-based ethics in the Thai context.

3.2.3 Study of acceptance of technology

This section used the same population as in the first stage (novice and professional designers); however, the sample in this stage are those who had tested the AI system and complete an AI Acceptance Survey. The data collected were processed through descriptive statistical methods, namely the mean and standard deviation (S.D.).

4. RESULTS

4.1 Efficiency testing results of the developed AI system

A comparative analysis of efficiency between the traditional digital method and the AI-Assisted method for both undergraduate students and professional designers is presented in Table 1. In this study, the “traditional digital method” refers to manual 3D sculpting and digital modeling processes, in which designers construct forms from scratch. This workflow relies heavily on human expertise and typically requires considerable time to refine intricate details, particularly when dealing with complex Thai ornamental patterns. The software referenced as part of this traditional approach includes Autodesk Maya, Blender, ZBrush, and Cinema 4D. These tools were identified based on data collected from digital sculpture artists, who reported using different software depending on their individual workflows and levels of expertise.

Table 1: Comparison of efficiency analysis results for the AI system across sample groups.

Sample groups	Method (Variable)	Mean	S.D.	Correlation	t	df	Sig. (2-tailed)	95% Confidence interval of the difference
Undergraduate students (n = 180)	Traditional digital method	3.69	.95	.418				
	AI-assisted method	4.40	.57					
	Difference	-0.71	.88		-10.77	179	.000*	(-0.84, -0.58)
Professional designers (n = 30)	Traditional digital method	3.59	.92	.361				
	AI-assisted method	4.18	.57					
	Difference	-0.59	.89		-3.65	29	.001*	(-0.93, -0.26)

Statistically significant at the .05 level.

The results presented in Table 1 clearly show that the AI system was significantly more efficient in producing Buddhist sculpture designs compared to the (traditional) digital system for both types of participants at a 0.05 significance level.

1) Efficiency results for undergraduate students: The mean efficiency scores for the undergraduate students were found to be significantly greater when they used the AI system compared to the traditional digital system ($M = 3.69$ vs $M = 4.40$). The t-test analysis showed that there was a statistically significant difference between the two methods with a mean difference of -0.71 ($t(179) = -10.77$, $p < .001$, 95% CI [-0.84, -0.58]).

2) Efficiency results for professional designers: Similarly, professional designers had an increase in the mean efficiency scores from 3.59 to 4.18 when using the AI system, which resulted in a mean difference of -0.59 ($t(29) = -3.65$, $p = .001$, 95% CI [-0.93, -0.26]).

These results clearly show a significant positive effect of the AI system on the design process, indicating that the AI system can assist both novice and experienced users throughout their design process.

4.2 Research findings on the role of AI in creating digital Buddhist sculptures in the context of Thai Buddhist art and culture

The thematic analysis of qualitative data from in-depth interviews with nine subject matter experts representing three distinct disciplines identified three major themes.

4.2.1 Limitations in AI's ability to convey cultural complexity and semantic symbolism

Experts across all three disciplines indicated that there exists a layer of cultural complexity and semantic symbolism that AI has not yet been able to reproduce accurately. The primary obstacles were limited access to source data, abstract interpretation, and the symbolic relationships between aspects of art and religion. In Thai Buddhism, art is not merely visual; it serves as a semiotic system whose meaning is deeply rooted in religious contexts, faith, sacredness, and the local community's cultural values and beliefs. As such, these aspects of the art are highly subjective and are difficult to convert into machine readable data for comprehensive AI training. Therefore, AI does not interpret the symbolic meaning of Thai Buddhist art at a high level of abstraction because it lacks an accurate and comprehensive symbolic database, expert validation, and the capacity to understand the nuances of religion in the way that humans do. These represent structural barriers in the use of AI for the creation of digital Buddhist art.

4.2.2 Balancing the benefits of efficiency enhancement with the need for cultural authenticity

All three expert groups agreed that while AI may increase production efficiency and precision, particularly in the area of basic modeling and image processing, human oversight would continue to be essential to ensure cultural authenticity. Cultural authenticity refers to the essence of Thai Buddhist art, which includes form accuracy, correct representation of religious and ethical principles, and cultural rights and data integrity. If AI is unable to acquire and comprehend the cultural authenticity of Thailand, it may produce culturally incorrect works that could lead to broad misunderstanding of both art and religion.

4.2.3 AI as an assistive tool for human oversight

Experts also stated that while AI has a great deal of potential for application in Thai Buddhist sculpture, it is dependent upon human oversight. Experts agreed that AI should not be considered the creator of Buddhist art but rather an aid for drafting and quality assurance. This approach allows artists to preserve the value, beauty, and sacredness of Thai Buddhist art for generations to come. Additionally, by positioning AI as a supporting tool for humans, it will contribute to the dissemination of knowledge and allow for sustainable creative opportunities in the future.

4.3 Technology acceptance of AI for digital Buddhist sculpture

Table 2: Mean and standard deviation of AI technology acceptance for digital Buddhist sculpture

Assessment items	Undergraduate students (n = 180)		Professional designers (n = 30)	
	Mean	S.D.	Mean	S.D.
1. Perceived Usefulness (PU)	4.36	.81	4.00	.91
Reduces complexity in creating 3D Thai patterns	4.29	.84	4.10	.95
System functions are sufficient for user requirements	4.29	.77	4.17	.88
Increases cost-effectiveness compared to traditional methods	4.45	.75	4.10	.83
Reduces costs associated with 3D software usage	4.42	.84	4.10	.92
Enhances work efficiency in the Thai pattern creation process	4.35	.80	4.03	.92
Reduces cumbersome steps in creating 3D Thai forms	4.33	.84	4.08	.96
2. Perceived Ease of Use (PEOU)	4.38	.75	4.15	.84
Users can quickly start using the AI system	4.43	.68	4.23	.77
User Interface/User Experience (UI/UX) facilitates convenient use	4.41	.77	4.23	.86
The AI system is simple and uncomplicated to use	4.38	.74	4.20	.81
Learning to operate the system requires minimal time and effort	4.36	.78	4.07	.87
Reduces complex steps, resulting in faster workflows	4.36	.77	4.17	.83
Reduces the learning curve for 3D Thai modeling software	4.32	.77	4.00	.87
3. Satisfaction to Use	4.30	.76	4.04	.81
Users are satisfied with the AI system usage	4.38	.74	4.10	.80
Users are satisfied with the overall aesthetics of the generated Thai patterns	4.33	.77	4.07	.87
The overall quality and beauty of 3D models meet expectations	4.31	.73	4.07	.74
The AI system generates beautiful and exquisite Thai forms	4.34	.74	4.17	.79
Details of the generated 3D Thai forms are intricate	4.22	.74	3.90	.76
Generated 3D Thai forms possess sharp details resembling the original	4.24	.82	3.93	.87

Table 2: Mean and standard deviation of AI technology acceptance for digital Buddhist sculpture (continued)

Assessment items	Undergraduate students (n = 180)		Professional designers (n = 30)	
	Mean	S.D.	Mean	S.D.
4. Intention to Use	4.31	.79	4.06	.85
Supports usage across multiple platforms (Chrome, Edge, Safari)	4.28	.77	4.00	.79
The AI system is stable with no interruptions during use	4.11	.94	3.87	.97
Reduces the workload of manually creating 3D models	4.37	.74	4.13	.82
The AI system effectively generates texture and depth of Thai patterns	4.41	.77	4.10	.84
The AI system maintains pattern continuity effectively	4.31	.75	4.10	.84
Generated 3D Thai forms are complete with no missing parts	4.39	.74	4.13	.82
5. Actual Use	4.33	.77	4.11	.85
Accurately imports and converts 2D images to 3D	4.26	.78	4.03	.85
Accurately generates Thai patterns according to user requirements	4.17	.80	3.97	.85
Reduces design time compared to traditional methods	4.41	.71	4.23	.77
Generates 3D models from 2D images faster than traditional methods	4.38	.69	4.20	.76
Generated 3D forms have correct proportions based on 2D prototypes	4.36	.80	4.07	.91
Generated 3D forms are viable for actual design applications	4.38	.81	4.13	.94
Overall AI Technology Acceptance	4.33	.78	4.09	.84

The results in Table 2 illustrate that there is an extremely high degree of acceptance of AI technology among participants in both the undergraduate student group and the professional designer group. A comparison of the two groups shows that the students had a slightly higher mean level of overall acceptance ($M = 4.33$, $S.D. = 0.78$) than the professional designers ($M = 4.09$, $S.D. = 0.84$).

In addition, when examining each individual dimension, the undergraduate student group scored higher on Perceived Ease of Use ($M = 4.38$, $S.D. = 0.75$), while the professional designer group also rated Perceived Ease of Use ($M = 4.15$, $S.D. = 0.84$) the highest score.

For the undergraduate student group, the next highest scored dimensions included Perceived Usefulness ($M = 4.36$, $S.D. = 0.81$) and Actual Use ($M = 4.33$, $S.D. = 0.77$).

For the professional designer group, the next highest scored dimensions after Perceived Ease of Use were Actual Use ($M = 4.11$, $S.D. = 0.85$) and then Perceived Usefulness ($M = 4.08$, $S.D. = 0.91$).

Both groups ranked Intention to Use fourth (undergraduate student group: $M = 4.31$, $S.D. = 0.79$; professional designer group: $M = 4.06$, $S.D. = 0.85$), and lastly, Satisfaction to Use was given the least amount of points relative to the other dimensions, but remained at a high level (undergraduate student group: $M = 4.30$, $S.D. = 0.76$; professional designer group: $M = 4.04$, $S.D. = 0.81$).

Overall, the acceptance trends are very similar between the two groups and point out that the ease of use is the most important aspect, and that both groups have a high level of overall acceptance for all of the dimensions of the AI technology.

5. DISCUSSION AND CONCLUSION

5.1 Efficiency of an AI system created for producing digital Buddhist sculptures

Results from both sample populations indicated that the designed AI system dramatically improved traditional digital sculpture methods ($p < .05$). As such, these results are congruent with the Technology Acceptance Model (TAM) proposed by Alshammari and Al-Mamary (2025), which states that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) directly affect technology adoption. The high efficiency ratings of the AI system clearly show that the AI enhanced the accuracy, reduced production times, and facilitated the completion of complex design tasks. Accordingly, users believe the AI possesses substantial

utility for the digital creation of Buddhist sculptures, thus supporting the system's effectiveness in creating an environment where users feel they will benefit from using it.

Moreover, the systems' capabilities to support learning and utilization correspond to the PEOU dimension identified by Davis as an important factor influencing attitudes toward the use of technology. Further evidence suggests that AI has been shown to reduce cognitive loads associated with technical aspects of work, thus freeing designers to spend their time verifying artistic detail rather than spending excessive amounts of time on technical issues. Thus, the AI system's effectiveness provides not only technical advantages but also aids in the adoption at both the attitudinal and behavioral levels as defined by TAM.

5.2 Role of AI in the context of Thai art and culture

The thematic analysis provided insight into how AI is used in the creation of Buddhist sculpture in support of multiple aspects of this creative process, in line with Lotman's Cultural Semiotics framework (Jinshun & Jun, 2021). Lotman viewed art as a semiotic system; thus, art must be understood through the lens of the "semiosphere" of history, belief, and the community's world view. In addition, when an AI system is trained on a systematic Thai Buddhist art database, the output of the system can represent cultural codes (Characteristics of the Great Man, Mahapurusa Laksana; posture, etc.) of various artistic periods.

However, the experts found that there was a difference between the AI system's morphological accuracy in producing Buddha images and the spiritual semantics of the images, supporting the work of Singhasonthi and Purisuttamo (2020) and Thitasabho et al. (2023), who explain that Thai Buddhist art is a cultural language that conveys the Dhamma, faith, and ideals. Therefore, although AI can aid in the technical aspects of the creation of Thai Buddhist sculptures, the ritualistic intentions and religious values must always be overseen by local experts.

This finding suggests two possible pathways for the future development of AI systems in this domain. First, improvements may be achieved through enhanced semantic tagging and the development of more sophisticated cultural ontologies that encode symbolic meanings, religious narratives, and contextual relationships within Thai Buddhist art. By integrating such structured knowledge into training datasets, AI systems may better approximate the intended symbolic and spiritual dimensions of the artwork. Second, the experts also indicated that the absence of "spiritual semantics" may represent an intrinsic limitation of current AI technologies, as spiritual meaning is often rooted in lived experience, intentionality, and cultural consciousness that extends beyond formalizable data. As a result, human intervention—particularly from artists, monks, or cultural experts—remains essential to validate, interpret, and imbue the generated works with appropriate spiritual significance.

The qualitative findings illustrate the important concept that AI cannot fully replace artists or experts today. Rather, AI is an instrument to improve the quality of work, increase the work efficiency, and ensure the consistency of the symbolic system in Thai Buddhist art.

This study further contributes to the application of cultural semiotics by demonstrating that AI-generated outputs can successfully reproduce surface-level cultural codes, but remain limited in capturing deeper layers of meaning embedded within the semiosphere, particularly those related to spirituality, belief, and ritual significance. This distinction highlights the boundary between computational representation and culturally situated interpretation, reinforcing the need to conceptualize AI not as an autonomous creator, but rather as a semiotic tool operating within human-guided cultural systems.

5.3 Technology acceptance among designers creating digital Buddhist sculpture

TAM can be used to analyze designers' acceptance of AI (Alshammari & Al-Mamary, 2025). Designers believed that AI greatly increased the efficiency and accuracy of the creation and preservation of symbols of Thai art and culture, especially in terms of maintaining symbolic accuracy and artistic style. This ability to generate and model complex physical forms, as discussed by Elgammal et al. (2018), allows users to identify the value and advantages of applying AI to Thai art and culture.

Specifically, the user-friendly UI/UX of the software decreases the technical barriers to usage and therefore increases the opportunities for adoption, as mentioned by Inkong (2023). The precision in creating and preserving the artistic identity and symbolic meanings of works of art, combined with the commitment to adhering to AI ethics concerning respect for cultural and religious values (Floridi & Cowls, 2022), creates trust and Satisfaction to Use. Subsequent Satisfaction to Use will lead to the Intention to Use as users identify the value and the ease of use. In terms of the Actual Use observed during the fieldwork, both novice and experienced designers demonstrated strong acceptance of AI for Thai pattern design and digital sculpture. Factors that influenced acceptance were the amount of time required to complete a design compared to other traditional methods, the ability of the AI to create 3D models from 2D images rapidly, and the practical applicability of the generated 3D forms to real-world uses. These findings demonstrate the TAM principle that PU and PEOU have a direct impact on actual usage behaviors.

This study has clearly demonstrated that the AI created in this study is capable of generating digital Buddhist sculptures with great precision, in less time than traditional methods, and with the ability to create intricate sculptures, which supports the TAM model's predictions regarding perceived usefulness and ease of use, resulting in increased user acceptance and usage. The AI also provides an ability to maintain aspects of cultural codes and significant symbolism from Thai Buddhist art to a degree; however, as previously stated, it is still necessary for experts to supervise AI-generated images so that they are able to preserve the religious beliefs associated with the artwork and provide the semantic meaning to the viewer as defined by Cultural Semiotics, demonstrating how the relationships between art, the culture within which it is produced, and the beliefs that drive its creation are all interconnected.

The design community views AI as a tool that can enhance productivity through reduced technical barriers, reduce the effort required to create an image, and increase user experience through ease of use, which results in greater user satisfaction and a sustained desire to continue using the tool. For this reason, when applying AI to art that represents highly symbolic, culturally contextualized content, it is advisable to preserve cultural codes and symbolic meanings to avoid the potential for the artwork being misinterpreted or losing spiritual value.

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DECLARATION

1. Conflict of interest

The authors declare no conflict of interest.

2. Generative AI and AI-assisted technologies in the writing process

The authors used ChatGPT (GPT-5.3, OpenAI) for language translation support during the preparation of this manuscript. However, the generated outputs were not used directly, as the study involves specialized terminology requiring domain-specific accuracy. The authors subsequently relied on professional language-editing and translation services provided by the Division of Research Facilitation and Dissemination, at Mahasarakham University. All content was carefully reviewed, revised, and finalized by the authors, who take full responsibility for the accuracy and integrity of the manuscript.

3. Data availability statement

The data supporting the findings of this study have been anonymized, and all personally identifiable information has been removed to ensure participant confidentiality and compliance with research ethics standards. The dataset is publicly available at: <https://doi.org/10.6084/m9.figshare.31925925>.

4. Ethics statement

Written informed consent was obtained from all participants prior to their inclusion in the study. The consent process was conducted in accordance with the protocol approved by the Mahasarakham University Ethics Committee for Research Involving Human Subjects (Approval No. 481-454/2024). The ethical approval was valid for the period from August 1, 2024 to July 30, 2025.

5. Contributor Role Taxonomy (CRediT)

Ninlagarn Boobpachote: Conceptualization, Data curation, Resources, Software, Visualization.

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