

# The Use Of AI In Printing Designs To Preserve Saudi Heritage

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## Abstract

*This research investigates the application of artificial intelligence (AI) in the printing of designs with the aim of safeguarding Saudi heritage. Specifically, it examines how traditional symbols and motifs are portrayed in modern design. By leveraging the wealth of Saudi artistic heritage and the wide array of prevalent motifs, this study examines the capacity of artificial intelligence technology to faithfully replicate and depict cultural subtleties in the realm of design. This study is consistent with prior research that highlights the significance of fashion and textile design in the formation and maintenance of national identity via the integration of traditional symbols. By conducting an extensive review of the relevant literature, the study further emphasizes the importance of actively participating in efforts to safeguard popular symbols against obsolescence and to fortify national identity in the Arab world. The results indicate that AI may improve the effectiveness, accessibility, and cost-efficiency of safeguarding Saudi heritage designs. However, this raises concerns regarding the need for human oversight to guarantee the designs' authenticity and precision. Furthermore, the incorporation of conventional symbols and motifs into contemporary designs is perceived as a method of enhancing the domain of design while also making a contribution to Saudi Arabia's cultural heritage. The study's conclusion pleads for additional investigation into the potential of AI in safeguarding additional facets of Saudi culture and heritage, emphasizing the imperative for ongoing research in this domain.*

**Keywords:** Artificial Intelligence, Printing Designs, Saudi Heritage, Traditional Symbols, Cultural Preservation, National Identity, Authenticity, Cultural Heritage.

## 1. Introduction

The preservation of cultural heritage is of paramount importance in maintaining a nation's identity and promoting cultural understanding. In Saudi Arabia, there is a rich and diverse cultural heritage that spans centuries, encompassing traditional designs, motifs, and symbols. As technology advances, the use of artificial intelligence (AI) in printing designs offers new possibilities for preserving and disseminating Saudi heritage. The use of AI in the preservation of Saudi heritage via the printing of designs is a subject of great interest. The preservation and conservation of heritage are crucial in maintaining the character of a city, serving as a

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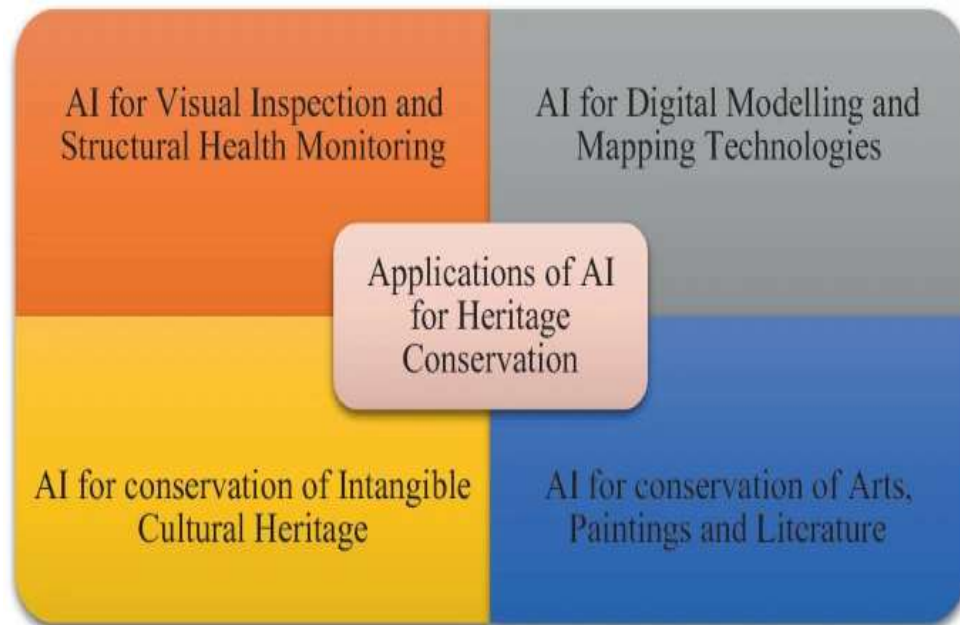
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foundational element that ensures its continuity for future generations<sup>1</sup>. In the contemporary digital age, the use of cutting-edge technology has emerged as a crucial determinant in the safeguarding and maintenance of cultural assets. AI-based automation has emerged as a prominent technological advancement in the realm of cultural protection and preservation (Mansuri and Patel, 2022).

AI applications for heritage conservation can be categorized into four groups: (i) AI for digital modeling, (ii) AI for intangible heritage, (iv) AI for cultural heritage, and (iii) AI for visual inspection and structural health monitoring<sup>1</sup>. AI has also found applications in the domains of cultural and built heritage conservation and preservation (Figure 1; Udeaja et al., 2020).



**Figure 1.** The use of AI in heritage preservation (Mansuri and Patel, 2022).

AI has significantly transformed the process of print layout creation within the print industry. AI-assisted print layouts contribute to waste reduction by optimizing the use of print material via automated processes. Smart layouts are designed in a proactive manner to effectively use the available space on each page, regardless of whether the printing involves basic circular shapes or intricate diecuts (Ramcharan et al., 2017; Mansuri et al., 2019).

The creation of Saudi Sadu shapes in Saudi Arabia has served as a source of inspiration for modern printing patterns. This study seeks to explore the potential of incorporating elements and forms from the Saudi heritage sadu into contemporary printing designs. It aims to demonstrate how the construction of sadu forms can influence these designs, highlighting their cohesive nature and integration. The study employs an experimental approach to examine and determine the impact of incorporating Saudi Sadu forms on inspiring contemporary print designs. Additionally, it explores the potential benefits of utilizing these designs in enhancing the cognitive aspects and performance skills of students studying Art education (Mohammed Saleh Al-Barrak, 2021). Based on the aforementioned information, our study aims to investigate the use of AI in printing designs to preserve Saudi heritage, with a focus on its impact, potential benefits, and challenges.

### 1.1. Research Objectives

The primary objective of this study is to explore the role of AI applications in printing designs to preserve Saudi heritage. The specific research objectives are as follows:

- a) To examine the current state of AI technology in printing designs and its potential for preserving Saudi heritage.
- b) To assess the impact and benefits of AI in preserving Saudi heritage through nostalgic designs.
- c) To identify the challenges and ethical considerations associated with the use of AI in preserving Saudi heritage.
- d) To propose recommendations for maximizing the potential of AI in preserving and disseminating Saudi heritage through printing designs.

## **2. Literature Review**

The preservation of cultural heritage places is of utmost significance in the protection and conservation of the abundant historical, artistic, and sociological inheritances of civilizations, ensuring their accessibility to both current and future generations. These websites serve as vital reservoirs of identity, tradition, and information, encapsulating the essence of human innovation and inventiveness. Nevertheless, these invaluable cultural resources are vulnerable to deterioration and obliteration due to the fast process of urbanization, alterations in the environment, occurrences of natural calamities, and human interventions. Therefore, it is vital to use collaborative endeavors and multidisciplinary methodologies in order to develop efficient preservation techniques that guarantee the safeguarding and sustainable administration of these sites. Zhang and Yuen (2022) provide an overview of the importance of safeguarding cultural heritage sites. It examines the difficulties presented by different factors, the various approaches used for preservation, and the incorporation of technological advances, legislation, and community involvement in the preservation of these priceless human treasures.

The research highlights the use of "distant sensing big data" for the purpose of assessing historic buildings on the Qinghai-Tibet Plateau, with the aim of supporting policy development, implementing technological interventions, and conducting field investigations. This study examines a total of 152 Buddhist monasteries over a span of 20 years, from 1993 to 2013. The research utilizes affordable macro-scale observations and open satellite imagery to analyze three distinct locations that have seen essential urban growth. Acknowledging the inherent constraints, such as the need for further nocturnal luminosity data rectification and additional inquiries, the research suggests the amalgamation of various remote sensing datasets, geographical variables, and financial indicators to augment surveillance capabilities and establish preemptive alert systems.

According to Zhang et al. (2018), the use of big data for evaluating objectives might be given priority in order to establish sustainable strategies for the preservation of architectural heritage in the face of urbanization problems on the Qinghai-Tibet Plateau. This study introduces a complete methodology for improving contextualized information retrieval in the field of risk management via the integration of Virtual Reality (VR) and Heritage Building Information Modeling (HBIM) data. This research presents the implementation of metadata that has been specifically created to offer contextual data based on the 5W1H model. The objective of this implementation is to enhance risk management inside a virtual reality (VR) environment. The VR apps that have been created have various interfaces to cater to different sorts of risk management. Nevertheless, several limitations were seen in the program. For instance, the application exhibited a constraint in its capacity to discern the objectives of the heritage management beyond the user's location. This hindered the feasibility of comparing the real-world elements with the virtual components on a unified screen.

Additionally, the application lacked the functionality of operating the camera for recording the status of the historic site. To overcome these constraints, the research suggests a potential enhancement via the use of Augmented Reality (AR) applications. This proposed improvement involves the integration of GPS, IMU sensors, and computer vision technologies to augment user location and facilitate interactions with object-related information. The researchers want to develop an AR application that will be implemented on-site. This application will have the capability to identify various components and provide relevant information and media overlays. The primary objective of this development is to enhance the efficiency of heritage preservation and risk management. (Lee et al., 2019).

In a study conducted by Tapete and Cigna (2018), an assessment was made on the capabilities of the multispectral system Sentinel-2, which is part of the Earth monitoring program Copernicus initiated by the European Commission. The objective of the study was to determine the effectiveness of this constellation in identifying significant characteristics and alterations in historic sites, both in normal circumstances and during times of crisis. The spatial resolution of the three visible spectral bands of Sentinel-2 was tested at a 10-meter scale to provide evidence for individual local occurrences. Through the analysis of extensive Sentinel-2 time series data, the researchers have successfully proven the precise monitoring of temporal and spatial changes in textural characteristics and surface reflectance. These changes have been effectively linked to significant events pertaining to conservation efforts.

Uhl et al. (2019) introduced a machine-learning framework that utilizes automation to extract symbols of human settlements, such as buildings and urban areas, from historical topographic maps. Notably, this framework is designed to function even in the absence of training data by leveraging modern geographic data as ancillary information to guide the gathering of training samples. The aforementioned samples are then used in the training process of a convolutional neural network, with the objective of achieving semantic picture segmentation. This enables the extraction of discernible human settlement patterns, which are then represented in a geographic vector data format suitable for research.

Lamas et al. (2021) proposed the MonuMAI structure (Monument with Mathematics and Artificial Intelligence) with the aim of utilizing image-based automatic systems to enhance the identification of architectural styles and detection of architectural elements in monuments. The authors argue that such advancements can contribute to the advancement of knowledge in the fields of history and art.

Moreover, Oonk and Spijker (2015) used data fusion techniques to combine multi-element XRF data obtained from archaeological site soils and regional background soils. The purpose of their research was to evaluate the synergistic benefits of integrating geochemical analysis with machine learning algorithms in predictive modeling within the field of archaeology. The authors of this study successfully included several data sources and using machine learning models to classify archaeological soil and background soil. They then evaluated the forecasts made by these algorithms with existing archaeological understanding and built forecasting models in three verification sites.

In a study conducted by Villarin and Rodriguez-Galiano (2019), the authors demonstrated the use of machine learning (ML) techniques for the development of a predictive model pertaining to water demand within the city of Seville, Spain. This model was constructed at the level of census tracts. The researchers used categorization and regression trees (CART) and random forest (RF) techniques, which are considered as multifaceted, regionally nonstationary, and nonlinear machine learning methodologies. In a similar manner, Granata and Di Nunno (2021) devised many forecasting models to anticipate the tide level of Venice city. Three

variations of each model were constructed, with different machine learning algorithms carried out: M5P Regression Tree, Random Forest, and Multilayer Perceptron.

### **3. Methodology**

#### **3.1. Research Design**

The present study used a mixed-methods research design, integrating both qualitative and quantitative methodologies. The research methodology encompasses the use of both primary and secondary data gathering techniques in order to get a full comprehension of the application of AI in the realm of printing designs, specifically with regards to the preservation of Saudi Arabian heritage.

#### **3.2. Literature Review**

In order to build a comprehensive theoretical framework, it is important to conduct an extensive assessment of the available literature pertaining to AI, heritage preservation, and printing designs. Conduct a comprehensive examination of academic publications, books, research papers, and reports sourced from trustworthy sources in order to get a thorough understanding of the present level of knowledge within this particular field.

#### **3.3. Research Tool**

A well-structured questionnaire was used to get quantitative information from pertinent parties, including AI technology users, designers, artists, and specialists on cultural heritage. The survey aims to evaluate participants' opinions, experiences, and attitudes about the use of artificial intelligence in the context of printing designs for historical preservation. The survey should be conducted either online or in-person, with careful consideration given to obtaining a representative sample.

#### **3.4. Data Analysis**

Data collected from surveys, interviews, and case studies will be analyzed using qualitative and quantitative analysis techniques. Thematic analysis will be employed to identify common themes, patterns, and insights from the qualitative data, while statistical analysis will be used to analyze the quantitative data.

#### **3.5. Ethical Considerations**

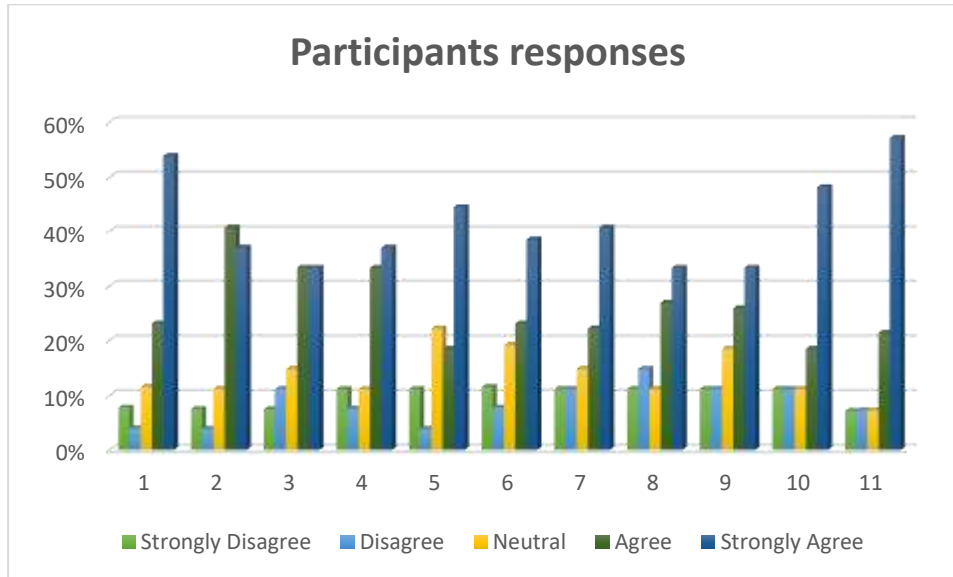
Maintain ethical principles throughout the study process. It is important to get informed permission from participants before commencing data collection. To ensure the preservation of participants' secrecy and anonymity, it is necessary to use pseudonyms or employ unique identifiers. It is essential to adhere to ethical norms while doing research that involves human participants, while also prioritizing the protection of data privacy and security.

### **4. Results**

#### **4.1. Analysis of the Questionnaire**

	<b>Questions</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neutral</b>	<b>Disagree</b>	<b>Strongly Disagree</b>
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<b>1</b>	<b>The use of AI in printing designs is an effective way to preserve Saudi heritage.</b>	53.8%	23.1%	11.5%	3.9%	7.7%
<b>2</b>	<b>AI can accurately represent the cultural nuances of Saudi heritage in design.</b>	37%	40.7%	11.1%	3.8%	7.4%
<b>3</b>	<b>I believe that AI technology is capable of preserving the authenticity of Saudi heritage in design.</b>	33.3%	33.3%	14.8%	11.1%	7.4%
<b>4</b>	<b>The use of AI in printing designs can help in the wider dissemination of Saudi heritage to a global audience.</b>	37%	33.3%	11.1%	7.5%	11.1%
<b>5</b>	<b>AI can help in reducing errors and inconsistencies in the representation of Saudi heritage designs.</b>	44.4%	18.5%	22.2%	3.8%	11.1%
<b>6</b>	<b>The use of AI in printing designs can increase the efficiency of preserving Saudi heritage.</b>	38.5%	23.1%	19.2%	7.7%	11.5%
<b>7</b>	<b>I trust AI to accurately represent Saudi heritage in design.</b>	40.7%	22.2%	14.8%	11.1%	11.1%
<b>8</b>	<b>AI should be trained on Saudi cultural norms and values before being used in design.</b>	33.3%	26.9%	11.1%	14.8%	11.1%
<b>9</b>	<b>Human designers should be involved in supervising the use of AI in preserving Saudi heritage designs.</b>	33.3%	25.9%	18.5%	11.1%	11.1%
<b>10</b>	<b>AI can help in reducing the costs associated with creating Saudi heritage designs.</b>	48.1%	18.5%	11.1%	11.1%	11.1%
<b>11</b>	<b>The use of AI in printing designs can help in increasing the accessibility of Saudi heritage to a wider audience.</b>	57.1%	21.4%	7.2%	7.2%	7.1%



**Figure 2.** Questionnaire responses.

## 5. Discussion

For the first statement, our findings indicated that the proportion of people who "strongly agree" (53.8%) is high. The majority of responders agree with the assertion that the use of AI in printing designs is an effective way to preserve Saudi heritage. Our findings in the second statement indicated that the proportion of people who "agree" (40.7%) is high. The majority of respondents agree with the assertion that AI can accurately represent the cultural nuances of Saudi heritage in design. Regarding the third statement, our results indicated that the proportion of people who "strongly agree and agree" (33.3%) is high. The majority of responders believe that AI technology is capable of preserving the authenticity of Saudi heritage in design. The findings of the fourth statement indicated that the proportion of people who "strongly agree" (37%) is high. The majority of respondents agree with the assertion that the use of AI in printing designs can help in the wider dissemination of Saudi heritage to a global audience. The data analyzed in the fifth statement indicated that the proportion of people who "strongly agree" (44.4%) is high. The majority of respondents agree with the assertion that AI can help in reducing errors and inconsistencies in the representation of Saudi heritage designs.

The sample distribution shown in the sixth statement indicated that the proportion of people who "strongly agree" (53.8%) is high. The majority of responders agree with the assertion that the use of AI in printing designs can increase the efficiency of preserving Saudi heritage. The vast majority of respondents in the seventh statement agree that they trust that AI to accurately represent Saudi heritage in design. The majority of respondents in the eighth statement agree with the assertion that AI should be trained on Saudi cultural norms and values before being used in design. The findings in the ninth statement indicated that the proportion of people who "strongly agree" (33.3%) is high. The majority of respondents agree with the assertion that human designers should be involved in supervising the use of AI in preserving Saudi heritage designs. The sample distribution in the tenth statement indicated that the proportion of people who "strongly agree" (48.1%) is high. The majority of respondents agree with the notion that AI can help in reducing the costs associated with creating Saudi heritage designs. Finally in the last statement, the majority of respondents agree with the assertion that the use of AI in printing designs can help in increasing the accessibility of Saudi heritage to a wider audience.

The ability to create numerous modern and authentic decorative designs by analyzing traditional symbols aligns with a study (Alissa, 2019) that emphasized the richness of Saudi art in rhythmic linear values, which artists and designers can draw inspiration from to achieve aesthetic beauty. This also corresponds to a study (Zalat, 2013) that highlighted the abundance of diverse popular Egyptian and Saudi motifs that enrich fashion design. Additionally, it is in line with a study (Khasifan, 2011) that emphasized the refinement of popular heritage values to bring their symbols to the forefront of creative imagination, providing artists with options from their artistic heritage in the realms of art and literature.

The role of fashion and textile design comes into play in establishing and preserving national identity through designs incorporating traditional symbols and motifs. The findings of a study (Nabawi, 2018) and (Abdel Azim, 2015) support the necessity of contributing to the process of establishing roots in the Arab world and protecting popular symbols from extinction, as the Arab popular heritage plays a positive and effective role in anchoring our national identity. This aligns with the main objective of this research. Breaking away from conventional systems in textile designs can be achieved through repetition and layering techniques. This corresponds to a study (Al-Shimi and Taha, 2011) that confirmed that creating decorative designs based on simple textile structures and relying on repetition and design principles leads to the attainment of numerous unprecedented visual and aesthetic values, enriching the field of design.

Thus, by investigating the use of AI in printing designs to preserve Saudi heritage, this research help in contributing to the body of knowledge on cultural heritage preservation, AI applications, and the intersection of technology and cultural identity. The findings of this study can inform policymakers, designers, and cultural organizations in Saudi Arabia and beyond, facilitating the development of strategies that leverage AI for the preservation and promotion of cultural heritage.

## 6. Conclusion

In conclusion, the application of artificial intelligence to the production of designs intended to safeguard Saudi heritage is an auspicious strategy that may aid in the propagation and conservation of Saudi cultural identity. The results of this research indicate that artificial intelligence has the capability to faithfully depict cultural subtleties and enhance the efficacy, availability, and economical nature of safeguarding Saudi heritage designs. However, human designers should oversee the operation of AI in order to guarantee the designs' authenticity and precision. Modern designs that incorporate traditional motifs and symbols can contribute to the establishment and preservation of national identity while also advancing the field of design. To investigate the potential of AI in preserving additional facets of Saudi culture and heritage, additional research is required.

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## Appendix 1

### Questionnaire

We appreciate your time in completing this form. This research seeks to determine whether the use of AI in printing designs can be utilized to safeguard Saudi heritage. Your insightful suggestions will assist us in comprehending the significance of utilizing AI in the production of designs in order to safeguard Saudi heritage.

Please select the appropriate response to the following questions using a five-point Likert scale as follows: 1 indicates "Strongly Agree," 2 indicates "Agree," 3 indicates "Neutral," 4 indicates "Disagree," and 5 indicates "Strongly Disagree." You are also permitted to include any ideas or remarks at the conclusion of the inquiry.

**1. The use of AI in printing designs is an effective way to preserve Saudi heritage.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**2. AI can accurately represent the cultural nuances of Saudi heritage in design.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**2. I believe that AI technology is capable of preserving the authenticity of Saudi heritage in design.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**3. The use of AI in printing designs can help in the wider dissemination of Saudi heritage to a global audience.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**4. AI can help in reducing errors and inconsistencies in the representation of Saudi heritage designs.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**5. The use of AI in printing designs can increase the efficiency of preserving Saudi heritage.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**6. I trust AI to accurately represent Saudi heritage in design.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**7. AI should be trained on Saudi cultural norms and values before being used in design.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**8. Human designers should be involved in supervising the use of AI in preserving Saudi heritage designs.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**9. AI can help in reducing the costs associated with creating Saudi heritage designs.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**10. The use of AI in printing designs can help in increasing the accessibility of Saudi heritage to a wider audience.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**11. AI can help in increasing the speed of creating Saudi heritage designs.**

- a. Strongly Agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly Disagree

**Thank You for your participation!**