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Technology impact evaluation on interior design students' graduation projects in dealing with heritage buildings

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Abstract. This research explores the impact of modern technologies used in engineering and architectural software on architectural education, with a particular focus on student projects that engage with heritage buildings. Heritage structures are especially sensitive and require careful design approaches due to their cultural and historical significance. The study highlights key architectural landmarks in the Jazan region of the Kingdom of Saudi Arabia, emphasizing their historical value and the need to preserve them as part of the nation's cultural identity. Through analyzing selected student projects, the research demonstrates how digital tools—such as 3D modeling and architectural visualization software—have allowed students to simulate reality and develop innovative design solutions that respect heritage contexts. These academic efforts reflect a broader methodological framework aimed at linking student work with real-world heritage preservation. Ultimately, the research supports integrating student creativity into national strategies aligned with Saudi Arabia's Vision 2030 to safeguard and revitalize historical architecture.
Keywords: Technology, Interior design students, Heritage buildings, Students graduation projects.

1 Introduction

In today's academic environment, computer applications have become widely accessible and commonly used by students of architecture and the arts. Despite this, the creative and innovative efforts that students invest in their graduation projects—especially those that go beyond conventional thinking—are often underutilized in practical fields. This is particularly true in areas where such efforts could contribute meaningfully to ministries and specialized institutions.

This research focuses specifically on graduation projects related to the rehabilitation of heritage buildings. It aims to explore the impact of technology on interior design students' projects, particularly those addressing heritage architecture. It also highlights the architectural significance of heritage landmarks in the Jazan region of the Kingdom of Saudi Arabia, emphasizing their cultural and historical value.

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The study underscores the role of technological tools and automation in architectural and design education, especially when working with historically significant buildings. It analyzes selected student projects that incorporate modern design software and innovative approaches in restoring heritage spaces. Moreover, the research investigates mechanisms through which student projects can serve as communication channels between academic work and real-world heritage preservation efforts.

Ultimately, the study proposes a framework for aligning student efforts with the broader goals of Saudi Arabia's Vision 2030. By doing so, it positions student projects as potential contributors to the country's cultural heritage preservation and sustainable development goals.

- **Research Problem**

Despite the extensive time and effort invested by students—particularly in graduation projects focused on heritage buildings—these projects are often not utilized beyond the academic setting. Typically, such projects are supervised by faculty members and evaluated by a three-member jury based on a standardized rubric. However, there is no clear methodology or mechanism in place to translate this academic work into practical applications, making it difficult to capitalize on students' creative output.

- **Research Questions:**

1. How do digital design tools enhance the creativity and effectiveness of interior design students in heritage building rehabilitation projects?
2. In what ways can graduation projects in interior design contribute to heritage conservation efforts and align with Saudi Arabia's Vision 2030?
3. What strategies can be developed to bridge the gap between academic work and practical applications in the field of cultural heritage preservation?

- **Research Objectives**

- This research aims to investigate the potential and mechanisms for utilizing interior design graduation projects focused on heritage buildings. It seeks to understand how these academic efforts can be connected to real-world needs, especially within the labor market. The objectives include:
- Examining the role of digital technology in enhancing students' engagement with heritage architecture.
- Highlighting the value of student projects as potential tools for heritage conservation.
- Proposing a methodological framework that facilitates the integration of student work into professional practices, in alignment with Saudi Arabia's Vision 2030.

- **Research Methodology:**

This study adopts a **qualitative, descriptive, and analytical research methodology**. The approach is structured to provide an in-depth analysis of graduation projects from the Interior Design Department, specifically those focused on the rehabilitation of heritage buildings. The research process is divided into several phases, as outlined below:

1. Research Design and Approach

The research utilizes a qualitative descriptive approach. This approach allows for an extensive exploration of the students' projects, focusing on the integration of digital tools and techniques in the rehabilitation of heritage buildings. The study seeks to understand how modern design tools enhance students' ability to address the challenges posed by heritage architecture. It also explores the impact of these projects on both the academic and professional fields related to heritage conservation.

2. Project Selection Criteria

Projects were selected for analysis based on their evaluation by a specialized academic jury. The jury assessed each project according to a standardized rubric that measures creativity,

technical accuracy, and relevance to heritage preservation. Only the highest-rated projects, which demonstrated substantial engagement with the challenges of heritage conservation, were chosen for analysis. The criterion ensured that the projects selected were both academically rigorous and practical for real-world applications in heritage building rehabilitation.

3. Data Collection

Data for this study were gathered through documentary analysis of the selected student projects. The documentation includes project reports, architectural drawings, digital models, and other relevant design outputs. Additionally, interviews with project supervisors and the students themselves were conducted to gain insight into the design process, the challenges faced, and the perceived impact of digital tools on the final outcomes.

4. Data Analysis Framework

The data were analyzed using a thematic analysis approach. Key themes such as digital tools, sustainability, architectural heritage preservation, and innovative design solutions were identified and analyzed. A comparative framework was established to examine the effectiveness of different digital tools in enhancing the technical and conceptual aspects of the projects. The analysis was conducted by coding the data into thematic categories and drawing connections between the design solutions and heritage conservation practices.

5. Evaluation of Impact

The impact of digital tools on the students' outputs and their ability to contribute to heritage preservation was evaluated. This evaluation was based on predefined criteria, which included the level of integration of sustainable design principles, use of climate-responsive features, and the alignment with Saudi Arabia's Vision 2030. The evaluation also considered how well the projects could potentially be implemented in real-world heritage conservation scenarios.

2 Digital technology in teaching architecture and design and its impact on heritage buildings

The world The world is witnessing daily advancements and new discoveries in computers and technology in general. This rapid and powerful development is considered one of the most influential factors impacting architecture and architectural education. As a result, modern architectural trends have begun to emerge, gradually raising the overall standard of architectural design. In the past, pencil and paper were the primary tools used to translate ideas into architectural drawings. Students would go through various stages of studying the project, leading to the final stage of manual drafting. However, with the emergence of technological advancements, computers have assumed significant and diverse roles in architectural education, becoming fast, accurate, and flexible tools for architectural drawing. This shift marked the beginning of the era of 3D modeling and the use of various programs such as AutoCAD, 3ds Max, Rhino, and SketchUp (Al-Daikh, 2005).

The digital revolution introduced the concept of digital forms, which quickly spread across various fields. Modern architectural theories contributed to the continuous development and renewal of these forms by integrating natural, organic, and geometric shapes to create free forms that reflect futuristic design trends. As a result, the digital revolution led to the creation of software that simplified the design process and enabled designers to predict the shapes of their projects through simulation programs. These tools allow architects to realistically represent their ideas and test the validity and feasibility of their designs before beginning any actual implementation (Samara & Qabbani, 2018; Ibrahim, 2019).

Through these programs, it is possible to create highly efficient environments that closely resemble real-life settings, helping to fulfill the psychological and sensory needs of users. The impact of these technologies can be observed in several areas:

- **Impact on the architect** – It has become easier for designers to immerse themselves in their projects and explore multiple alternatives for walls, ceilings, and floors—whether in terms of different layouts or materials. This design flexibility, along with the virtual environments provided by these programs, has enabled architects to engage more deeply with their designs and develop a stronger sense of spatial awareness and interaction (Ibrahim, 2019).

- **Impact on form generation** – The flexibility offered by digital tools in modifying designs and materials has made the process of shaping architectural forms both easier and more advanced. The efficiency and quality of this process depend largely on the speed and capabilities of the computer used, as well as the designer's skill level (Samara & Qabbani, 2018).
- **Impact on functionality** – The advancement of design software and the integration of virtual reality have made it easier to test and simulate various functional aspects of architectural spaces. This has contributed to achieving greater efficiency in ensuring that the intended functions of spaces are effectively realized (Al-Daikh, 2005).

All of these developments have led to a significant transformation in the approach to heritage buildings, which are known for their sensitivity and the need for careful handling. It has become inevitable that such advanced techniques are applied in the design and development of heritage spaces in order to achieve the most appropriate and effective architectural solutions (Ishteeaque & Alsaid, 2008).

Globally, digital technologies have also reshaped architectural pedagogy. Across many international institutions, the traditional "design studio" model has evolved into a hybrid of physical and digital formats. Salama (2015) emphasizes that digital platforms promote collaborative, student-centered learning by encouraging iterative processes and peer-to-peer feedback. Similarly, Araya (2020) notes that digital tools such as parametric modeling and simulation software not only boost creativity but also enhance students' ability to analyze and solve complex design problems—skills essential in contemporary architectural practice.

In parallel, global experiences in digital heritage conservation offer strong models for integrating technology with cultural sensitivity. The 3D reconstruction of Palmyra in Syria and digital documentation of Notre-Dame in Paris show how tools like laser scanning and Building Information Modeling (BIM) can be used to record, preserve, and even restore historical architecture with high precision (Guidi et al., 2014; De Luca, 2021). These tools also enable architects and scholars to simulate decay, predict structural failure, and develop adaptive reuse strategies—all before any physical intervention is made.

Beyond technical modeling, digital heritage now incorporates immersive technologies that enhance public engagement and educational access. Addison (2008) stresses that digital conservation should extend beyond aesthetics to include intangible heritage and historical narratives. Virtual and augmented reality platforms are being used in Europe, China, and the Middle East to bring ancient cities to life, engaging citizens and tourists alike in experiences that blend storytelling with historical accuracy. This not only enriches the user experience but also fosters wider community support for heritage preservation.

Framing this study within a global context, Egypt's cultural landscape provides fertile ground for advancing such practices. However, despite growing interest in digital methods, the systematic integration of these technologies into architectural pedagogy and heritage conservation remains in early stages. Projects in Egypt often lack the structured interdisciplinary frameworks seen in Western or East Asian contexts. Thus, this study aims to contextualize local architectural education and heritage design practices within the broader global discourse, highlighting how international trends can inform and enhance regional applications.

Another vital trend in international education is the move toward global digital equity. Cloud computing, remote collaboration tools, and open-access software are transforming how students around the world engage with architecture. Jenkins et al. (2021) highlight that digital platforms are increasingly being used to connect students from different continents in shared design projects, fostering global dialogue, creativity, and technical proficiency in real-time environments. This democratization of knowledge access is helping shape a new, globally conscious generation of architects.

Moreover, cross-sector collaborations in digital heritage have emerged as powerful models for integrated conservation. The EU-funded INCEPTION project exemplifies how semantic web

technologies, mobile interaction, and 3D visualization can create interactive, layered representations of cultural buildings (Messaoudi et al., 2018). These innovations allow heritage buildings to be digitally annotated and explored by the public, professionals, and educators alike—making heritage more inclusive, participatory, and sustainable. They also redefine the role of architects as mediators between history and innovation.

3 Heritage buildings in Jazan province:

The Kingdom of Saudi Arabia boasts a rich urban heritage, showcasing a wide array of architectural styles, functions, and cultural elements. The architecture in the Kingdom varies significantly due to its vast size and diverse climatic conditions. Each region possesses its own unique environmental and cultural characteristics, which are reflected in the architectural features, urban layouts, and building techniques specific to that area. Despite this diversity, the urban heritage across the Kingdom exhibits harmony and cohesion. National unity, along with adherence to shared social, cultural, and religious norms, serves as the foundation for this coherence. The differences in architectural styles are primarily influenced by the varying natural environments and climates found throughout the country. The farthest southwest region of Saudi Arabia is home to the Emirate of Jazan. The following section will highlight two significant heritage buildings from this region, examining their style, construction systems, and architectural design (King Abdullah University of Science and Technology, 2025).

Al Maftoul:

This model is located in the Faifa Mountains, in the southeastern part of the Jazan region, which is known for its integration of tourist attractions on the peaks of the mountain range. Ancient architecture is one of the key tourist features unique to the Faifa Mountains. Among the most significant examples are the “cylindrical houses” that the ancients were particularly interested in building. The people of the region demonstrated great creativity in the design of these houses, excelling in their floor layouts and creating a unique architectural heritage not found elsewhere. In addition to the aesthetic beauty of their design, each house has its own name, and every part of it is also named. Even the stones used in construction and the wood from which the roofs were made have specific names. The ancients were meticulous in choosing the locations for these houses, seeking protection from natural dangers such as floods and landslides, as well as from military threats. The positioning of these houses allowed them to have a strategic view of their surroundings. This strategic consideration was due to the prevalence of conflicts and violence in those times, before the unification and stabilization of the Kingdom’s security (Dwidar, 2020).

These houses featured a distinctive design in the past. The cylindrical houses were preferred for their strength and resilience, capable of withstanding storms. They referred to these cylindrical houses as “branched” and singled out a specific type of these houses, giving it extra care and fortification, calling it “lofty.” These houses were elevated over several floors and situated on a hill or mountaintop overlooking the surrounding farms. The entrances to these structures often served as guard towers or storage for weapons and supplies. The courtyard of the house could be surrounded by another “house” and a khalouf (an area designated for housing). If military preparations were made, they referred to the structure as a “fort,” similar to the Absiyah Fort or the Rumaih Fort. If the houses attached to it multiplied, they referred to it as a “village” (see Fig. 1).


Error! Reference source not found. Al-Absiya overlooking and Al-Rumaih Fort
Source: Researcher

Traditional architecture, whether in a mountain or desert setting, is characterized by its integration with the environment, serving both the environment and its inhabitants. The mountain house remains the ideal solution for the mountain environment, designed to meet the needs of its residents in all aspects, such as weather, security, and social needs. The Faifa house is particularly distinguished by the aromatic basins placed on the balconies of these houses. In addressing privacy, ventilation, and thermal adaptation, these houses benefit from the use of natural stone in construction, which acts as a thermal regulator. This feature cannot be fully replicated by modern insulation systems. Additionally, the aesthetic elements of these homes were carefully considered, with decorative features such as the ornamental stonework around the windows and at the top of the house, often using "quartz" or, scientifically known, "silica" stone. The architectural style of Faifa is one of the region's defining characteristics. These stone houses are renowned for their unique cylindrical shape and the high precision of their construction. While neighboring areas such as Tihama, Asir, and Yemen typically adopted the square-shaped design, only Faifa embraced this distinctive style (Ministry of Culture, 2025).

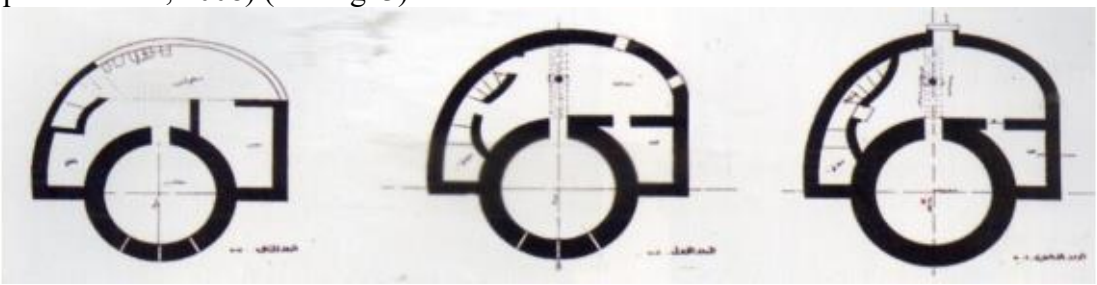
Architectural analysis of Al-Maftool

The Al-Maftool house is typically circular in shape and resembles a tower. It is strategically located on a high rock formation, which makes it easier to defend and protect from potential enemies. These houses are characterized by several notable features: the reinforcement of the structure to ensure strength and durability; the absence of windows, except for small openings for lighting and ventilation, which are placed at elevated positions to maintain privacy and prevent visibility from the outside. Additionally, it is worth noting that the lower floors of these houses do not have windows, primarily for security reasons. The locations of these houses are carefully chosen to ensure they are situated in places that overlook the surrounding areas and are difficult for enemies to access (Rashid, 2003) (see Fig. 2).

Fig. 2 Al-Maftool
Source: Researcher

Architectural design of the maftoul:

The design of stone buildings is characterized by vertical movement between different spaces. These buildings typically consist of three to four floors, with the possibility of expansion. Residents move between the various elements of the house, which are distributed across the floors, via stairs, with rooms often opening directly to these stairs. The design of stone buildings in the highlands depends on the number of floors, and each floor serves a specific function. The ground floor generally contains the main entrance, and sometimes an additional entrance for livestock. This floor also includes areas for sheltering livestock and storing grain. The main entrance leads to the stairs that connect the other floors. The first floor is used as the main sitting hall and reception area for guests, especially for large families. Part of it may also serve as storage for agricultural crops, while another section serves as a passage to other floors. The second floor is divided into two parts: one-third is used as a kitchen, and the remaining two-thirds are used as a sitting room, dining area, and sleeping quarters that can accommodate three or four beds. The third floor occupies about a quarter of the total area of the house, and is primarily used to store important items, including weapons and valuable furniture. Additionally, this floor includes a space for showering and washing. There are slight differences in the design of stone buildings depending on the location, including variations in size, area, height, and the names of the spaces within the house. For example, a special room for the head of the family is often located at the top of the building on the third or fourth floor. Moreover, an open space on the roof serves as an observation area, and small openings are strategically placed for defense purposes, such as for photography during times of war (Ishteeaque & Alsaid, 2008) (see Fig. 3).



Error! Reference source not found. Architectural plans of Maftool
Source: Dwidar, Salma. “Classification and analysis of urban and architectural heritage building in emirate of Jazan in kingdom of Saudi Arabia.” Journal of Engineering Sciences Assiut University, Faculty of Engineering. Vol. 48. (2020).

Construction materials:

The stones available in the surrounding mountains were used as the primary construction material, while wood was used for the roof. The interior was coated with a layer of clay or gypsum. The construction process follows these steps:

A) First, the site is selected, and building materials, including stones and wood, are prepared. The area of the maftool is then marked on the ground, and the foundations are built using larger stones.
B) Next, walls are constructed, typically about two cubits thick. This thickness gradually decreases as the height increases. The small gaps between the stones are filled with limestone to prevent air and insects from entering.
C) Window openings are kept small for safety reasons, and also to reduce heat transfer within the spaces.
D) The roof is constructed using timber.
E) The walls are covered with a layer of clay and lime from the outside to protect them.

Architectural Formation and Aesthetic Elements

A type of local white stone is used to decorate the window frames on the exterior. The interior is painted with a layer of plaster or clay, featuring some decorative elements and colors that enhance the aesthetic appeal. This decoration is typically the individual effort of the housewife.

Bioclimatic Performance (Environmental Control)

A) Small external openings are used, which helps reduce heat transfer from the outside to the interior.
B) The high ceiling of the building contributes to thermal comfort indoors, as hot air rises and is replaced by cooler air.
C) The use of locally available materials and thick walls reduces heat transfer from the outside to the inside (Awad, Fakhry, & Ibrahim, 2021) (see Fig. 4).

Fig. 4. Al Maftool Building
Source: Researcher

3.1 (Al Dosariyah castle)

Al Dosariyah Castle is a heritage building located in Jazan province, Kingdom of Saudi Arabia. It is perched atop a mountain, offering a panoramic view of the Red Sea harbor. The castle features a square-shaped layout, with each side measuring 34 meters. At the center of the castle is an open courtyard, and along its edges are four circular towers, each with a diameter of 17.60 meters. The building consists of a basement, ground floor, and roof floor (Rashid, 2003) (see Fig. 5).

Error! Reference source not found. Al Dosariyah castle
Source: https://heritage.moc.gov.sa/

Architectural Design:

The horizontal layout of the castle is square, with a tower at each corner. The castle consists of three floors. The lower floor is accessed through a rectangular door opening located in the middle of the western side of the castle courtyard. This floor includes two vestibules, which are rectangular spaces designated for the military garrison. These vestibules feature a wooden roof supported by an iron pillar.

The middle floor: The central courtyard of the castle is square in shape, with a side length of approximately 12.55 meters. This courtyard highlights the significance of the castle as a crucial source of lighting and ventilation, as well as a main communication element within the building. The courtyard is surrounded on its northern, western, and southern sides (Rashid, 2003) (see Fig. 6).

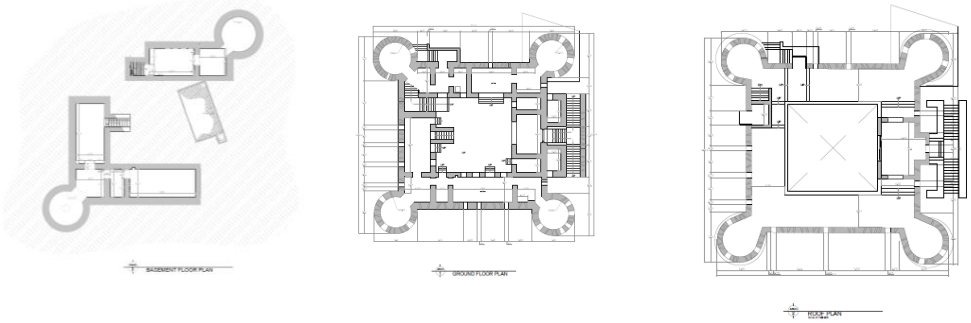


Fig. 6. The horizontal plan of basement, ground, and roof floor, respectively
Source: https://heritage.moc.gov.sa/

Construction materials:

Different types of building materials were used in the construction of Al-Dosariyah Castle, including stones of various shapes and sizes. Some of these stones were roughly trimmed, while others were finely carved on both the face and sides. These finely crafted stones, known as "carved lobe stone," were used in the interior sections of the castle as well as on the façades of the towers. Fillings made of small stones or dakshoum were employed, particularly in the solid floors of the towers and the staircases. Bricks were also used alongside stone and wood to form ceilings and to fill gaps between stone courses in the walls. Additionally, iron clay was incorporated into the ceilings in combination with wood to provide structural reinforcement. All these materials were bonded using plaster mixed with sand, and many sections of the walls were finished with a plaster coating.

Architectural Formation and Aesthetic Elements

The horizontal layout of the castle follows a symmetrical design, which enhances both its structural integrity and visual harmony. Refined local stones were used to create a distinctive and visually pleasing appearance. Aesthetic variety was introduced in the design of window openings, which ranged from square and rectangular forms to semi-circular arches. Similarly, doors and corridors were topped with semi-pointed circular arches, adding architectural elegance and rhythm to the design.

Bioclimatic Performance (Environmental Control)

Small external openings were used to reduce the transfer of heat from outside to inside. The central courtyard functioned as a thermal regulator, helping to generate airflow and maintain thermal balance within interior spaces. Thick walls, ranging from 0.8 to 1 meter in thickness and built from local materials, were utilized to insulate interior areas from external temperature changes. Moreover, the strategic location of the castle—on a mountain peak and along the seafront—enhanced natural ventilation by promoting continuous air movement throughout the structure (Rashid, 2003) (see Fig. 7).

Fig. 7. The horizontal plan of basement, ground, and roof floor, respectively
Source: https://heritage.moc.gov.sa/

4 Practical study:

Through automation, students in the fields of architecture and interior design have been able to produce multiple designs that successfully combine functionality with high aesthetic value in the design of interior spaces. This section focuses on analyzing selected projects by female students who studied heritage buildings and worked on revitalizing their interior spaces while maintaining the historical and cultural value of these places. These student projects represent part of the learning outcomes of the graduation project course (IND 506-6), offered by the Interior Design Department at the College of Design and Architecture, Jazan University. The students explored significant touristic, cultural, and heritage buildings and sites located in the Jazan region.

This project focuses on reviving the architecture of Faifa, a city known for its pleasant climate and diverse terrain, and distinguished by its unique architectural character—particularly in the use of local materials and traditional design, as previously discussed. In this project, the student worked on reviving the traditional circular house found in Faifa (locally known as Al-Maftoul, Al-Dara, or Al-Mishrah), within the framework of preserving the region's historical urban fabric.

The student designed hospitality models inspired by the heritage structure of Al-Maftoul, but reimagined through a modern lens. Her concept was guided by the objectives of Saudi Arabia's Vision 2030, particularly in enhancing the Kingdom's status as a global tourist destination and facilitating access to services and amenities for visitors.

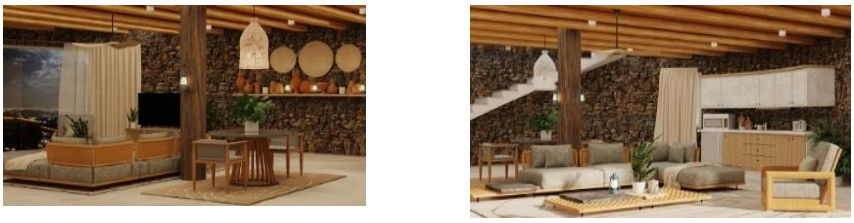
The result was a heritage-inspired design that maintained the core principles and foundations of traditional architecture, while adopting a contemporary approach. The same traditional building materials were preserved, along with the identity of the place, all while giving the project a simple, rural character. This was made possible with the help of digital design tools, as the student primarily used 3DS Max in her work.

For instance, she designed the ground floor to function as the living room, the first floor as the bedroom, and the upper floor to house a Jacuzzi. The student developed several versions of the design, experimenting with various forms and materials to reach the optimal solution. These design trials are illustrated in (see Fig. 8).

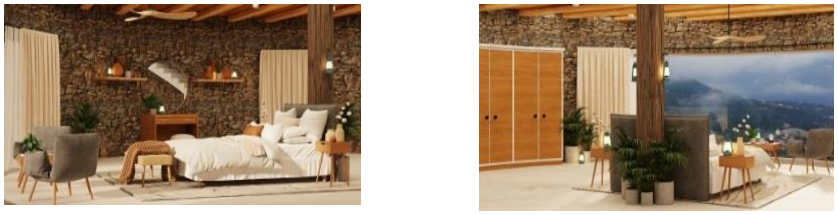
Fig. 8. Attempts by the student
Source: Students work (graduation Project 2023)

Final design outcomes of the Faifa Project:

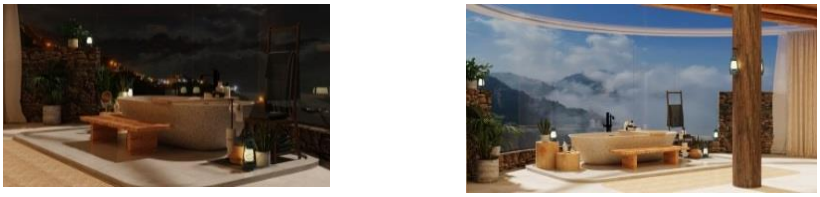
The student implemented the design concept based on a modern and organic rural style. After conducting numerous design trials and explorations, the final outcome reflected a balance between heritage inspiration and contemporary comfort. The following figure presents the student's finalized design for the three floors, showcasing the results of these iterative experiments (see Fig. 9).



Ground floor 3D shots



First floor 3D shots



Roof plan 3D shots

Fig. 9. Student final designs
Source: Students work (graduation Project 2023)

Analytical Framework

To evaluate the integration of digital technologies and sustainable strategies in the adaptive reuse of heritage architecture, this project applies a four-dimensional analytical framework. The assessment focuses on:

1. construction materials,
2. architectural formation and aesthetic elements,
3. sustainable furniture, and
4. bioclimatic performance.

These dimensions were selected to ensure a comprehensive understanding of how modern interventions can support functional upgrades while maintaining heritage integrity.

- **Construction Materials**
  Two approaches were applied. The first involved restoring the existing heritage buildings and repurposing them as tourist attractions, preserving their original character. The second approach involved reconstructing architectural models inspired by the original forms while adapting them to modern needs. For instance, in Faifa's climate—moderate for most of the year but reaching up to 33°C in summer—traditional small windows were replaced with large,

treated glass openings. These new elements help maintain thermal comfort while maximizing daylight and aesthetic continuity.

- **Architectural Formation and Aesthetic Elements**
  The design respected traditional architectural language by using the same type of local white stone for external window framing. Interior walls were finished with layers of gypsum or clay, enriched with delicate ornamentation and soft color tones. These materials and design decisions reflect a commitment to preserving the authenticity of traditional architecture while subtly modernizing it for contemporary use.
- **Furniture**
  Sustainable furniture was employed to ensure longevity, flexibility, and environmental responsibility. The design process emphasized material efficiency, multi-functionality, and ergonomic performance. Locally sourced and recyclable materials were incorporated—such as aluminum and processed agricultural waste (e.g., corn plants)—bound with non-toxic adhesives. This approach supports environmental sustainability and economic resilience by reducing dependency on imported materials and encouraging local production.
- **Bioclimatic Performance (Environmental Control)**
  Passive design strategies were employed to enhance interior comfort. Small external openings reduce heat gain, while high ceilings facilitate air circulation by allowing warm air to rise. The thick walls, combined with locally sourced thermal mass materials, contribute to maintaining a stable indoor climate, reducing the need for mechanical cooling. These methods reflect a blend of traditional bioclimatic knowledge with modern environmental awareness.

The second project:

Al-Dossaria Castle Project: In this project, the student repurposed the vacant spaces within the Al-Dossaria Castle building. She adopted an organic design approach for the interior space, inspired by the abundance of salt rock in the region, which formed the conceptual foundation for designing the exhibition area.

The student proposed the idea of transforming one of the castle's internal areas into a heritage exhibition space to serve as a tourist attraction, all while preserving the architectural identity of the historic building. The interior spaces were designed to reflect the unique characteristics and historical features of the castle. In addition, furniture pieces were custom-designed to match the function of the space, using the same local materials originally used in constructing the castle.

Her design concept was aligned with the goals of the Kingdom of Saudi Arabia's Vision 2030, which seeks to strengthen the Kingdom's status as a global tourism destination by promoting initiatives in the fields of heritage, culture, education, and the arts, while preserving the country's rich cultural and natural legacy.

The student developed a heritage-inspired design with a contemporary vision, maintaining the traditional foundations and principles of historical architecture. The identity of the site and the original construction materials were preserved throughout the design process. She also created customized display furniture to showcase heritage items, and was assisted by the use of specialized design software—most notably, 3DS MAX.

For instance, she redesigned one of the castle's halls to serve as an exhibition space and developed furniture pieces for the display of local nursery products. (See Fig. 10.) The design process involved multiple trials using different models and materials in order to reach the optimal solution.


Fig. 10. attempts by the student
Source: Students work (graduation Project 2022)

In her design, the student relied on the form and material of salt stone and adopted the organic style, which is characterized by environmental integration and treating the building as an extension of its natural surroundings. After conducting numerous experiments, as previously explained, the student succeeded in developing the final designs (see Fig. 11). Additionally, she designed a restaurant hall following the same design approach and methodology.


Final design of the exhibition hall


The final design of the restaurant

Fig. 11. Student final designs
Source: Students work (graduation Project 2022)

The main To assess the adaptive reuse of the heritage building in this project, a structured analytical framework was developed based on principles of sustainability, cultural preservation, and passive environmental design. The evaluation addresses four main criteria:

1. construction materials,
2. architectural formation and aesthetic elements,
3. locally inspired furniture, and
4. bioclimatic performance.

This framework ensures that the intervention respects heritage integrity while responding to contemporary functional and environmental needs.

- **Construction Materials**
  No new construction was undertaken, as the heritage structure was already in good condition. The design strategy focused on adaptive reuse by repurposing existing empty spaces to accommodate new functions while maintaining the structural and material integrity of the original building. This minimal intervention approach aligns with international conservation practices that advocate for authenticity and reversibility.
- **Architectural Formation and Aesthetic Elements**
  The reuse strategy preserved the castle's original aesthetic features, maintaining consistency with the building's historical character. Elements such as window shapes, façade treatments,

and proportions were left intact, ensuring that the adaptive reuse respects the architectural identity and cultural value of the original design while supporting new spatial functions.

- **Furniture**
  Furniture was produced using locally sourced materials such as wood and salt stone. This approach not only reinforces the cultural identity of the space but also reduces environmental impact by minimizing transportation and supporting local economic activity. The use of traditional materials within new functional layouts bridges the past and present, maintaining cultural relevance and sustainability.
- **Bioclimatic Performance (Environmental Control)**
  The building's design retains its original passive thermal strategies. Small external openings minimize heat gain, while the internal central courtyard enhances cross-ventilation and natural airflow. The thick stone walls—ranging from 80 to 100 cm—act as thermal mass, absorbing and releasing heat slowly, which helps maintain a comfortable indoor temperature throughout the day. These bioclimatic strategies reflect the environmental wisdom of traditional architecture adapted to contemporary reuse.

5 The result of practical study:

From the previous applied study, several important conclusions can be drawn that reflect the influence of technology and digital programming on architectural and interior design processes, from the initial design phase to implementation. Technology has had a significant positive impact on the design outcomes of architecture and interior design students, providing them with an unlimited number of opportunities for experimentation and creativity. Digital tools and computing have played a crucial role in enhancing the accuracy and speed of design execution, removing limitations on the designer's creativity and enabling more advanced and precise design models.

The studied projects demonstrate that the interest in heritage buildings is not only a global and local trend but also a fundamental matter for preserving cultural identity and promoting sustainability. Technological advancements in design can be effectively utilized to support and enhance the projects of architecture and interior design students, particularly in the preservation and revitalization of heritage buildings. The integration of digital programming has significantly elevated students' creativity in these areas, allowing them to engage with heritage buildings in ways that were not possible before.

Moreover, the study indicates that the practical application of digital technology not only provides students with a platform to explore new design ideas but also equips them with essential skills for the future of architectural practice, especially in relation to heritage preservation. The ability to replicate and simulate the existing structures digitally ensures a better understanding of their architectural value and facilitates the creation of designs that are both respectful of tradition and responsive to contemporary needs.

The results highlight the potential for collaboration between academic institutions and the heritage sector, where students' creativity can be directly applied to real-world challenges. Through this collaboration, the projects can contribute significantly to preserving the cultural heritage of regions while offering sustainable solutions for adaptive reuse. Additionally, the projects exemplify how students can merge traditional architectural identity with contemporary design elements, creating a fusion of heritage and modernity that meets both cultural and functional needs.

To summarize the key differences between the two projects, the following table (Table 1) presents a side-by-side comparison of the Faifa Project and Al-Dossaria Castle Project based on various evaluation criteria.

Based on the findings, the study recommends adopting a structured framework that enables the practical application of student projects, linking academic outcomes with the heritage and tourism sectors. Such a framework would support the preservation of historical buildings, foster cultural tourism, and align

with the goals of Saudi Arabia's Vision 2030, contributing to the sustainable development of cultural heritage as a national asset.

Table 1 Comparison of Faifa Project and Al-Dossaria Castle Project:

Criteria	Faifa Project	Al-Dossaria Castle Project
Heritage Preservation	Focused on reviving traditional circular houses (Al-Maftoul) with modern touches while preserving original materials.	Focused on repurposing existing heritage building (Al-Dossaria Castle) while preserving its historical identity.
Design Approach	Modern reinterpretation of heritage architecture, integrating sustainable design practices.	Organic design approach, blending traditional materials with modern functionalities.
Construction Materials	Local stone for aesthetic preservation; treated glass for better temperature control.	Local materials like salt stone and wood for authenticity and environmental integration.
Furniture Design	Sustainable, flexible, and multifunctional furniture made from recycled materials like corn plant waste and aluminum.	Custom-designed furniture using locally sourced materials to match the historic building's identity.
Environmental Control	Use of small windows, thick walls, and high ceilings to reduce thermal gain and enhance natural ventilation.	Thick stone walls and small external openings, with central courtyard to regulate temperature.
Bioclimatic Performance	Adapted to Faifa's climate by adjusting window sizes for better climate control.	Maintains traditional environmental efficiency with minimal alterations.
Digital Design Tools	Used 3DS Max for iterative design trials, enhancing creativity and precision.	Employed 3DS Max for conceptualization and customization of space designs.
Cultural Alignment	Aligned with Vision 2030 by focusing on tourism and sustainability in heritage design.	Aligned with Vision 2030, focusing on preserving cultural heritage while promoting tourism.
Target Functionality	Designed to enhance rural tourism with modern amenities in a traditional setting.	Transformed castle into a tourist exhibition space while maintaining historical integrity.

6 Conclusion:

This research has explored the evolving intersection between digital technology, architectural education, and heritage preservation through the lens of student graduation projects in the Kingdom of Saudi Arabia. By focusing on real-world heritage landmarks within the Jazan region, the study has demonstrated that student-led academic efforts—when supported by modern design tools—can transcend the boundaries of traditional education and offer meaningful contributions to the national heritage sector.

The findings affirm that the integration of architectural software, such as 3D modeling and simulation tools, significantly enhances students' creative capacities and technical precision. More importantly, it equips them with the necessary skills to approach sensitive heritage buildings with a thoughtful balance between innovation and preservation. The analyzed projects reflect a high level of engagement with

site-specific challenges, incorporating sustainable materials, bioclimatic solutions, and culturally responsive design strategies. These outcomes underscore the pedagogical value of embedding real-world challenges within academic curricula.

Furthermore, the study reveals a broader potential: student graduation projects, when guided by structured frameworks and collaborative mechanisms, can act as a bridge between academic institutions and heritage authorities. They represent a largely untapped resource for practical intervention in heritage rehabilitation, especially in alignment with the strategic goals of Saudi Arabia's Vision 2030. This vision calls for safeguarding cultural identity, fostering creativity, and promoting sustainable development all of which can be supported through the contributions of architecture and design students.

In conclusion, the research highlights the need for institutional efforts to integrate student outputs into national heritage initiatives. By formalizing partnerships, encouraging interdisciplinary collaboration, and adopting digital heritage preservation methods, academic institutions can play a critical role in cultivating a new generation of designers equipped to preserve the past while innovating for the future. The study ultimately reinforces that the educational process, when aligned with real societal goals, can produce both intellectual growth and tangible cultural impact.

7 Recommendations:

In light of the findings, this study proposes several key recommendations aimed at enhancing the role of digital tools, academic engagement, and sustainable practices in the preservation and reuse of heritage architecture. First, it is essential to emphasize the mastery of digital programming platforms such as 3DS Max, Maya, Rhino, Grasshopper, Dynamo, Marionette, and Flux. These tools not only foster creativity and design precision but also equip students with future-ready skills in line with global technological advancements in architecture and interior design.

The study also advocates for institutional support in showcasing student work, particularly through permanent exhibitions dedicated to heritage preservation projects. Such initiatives would provide students with valuable exposure, promote community awareness, and strengthen the cultural appreciation of architectural heritage through the lens of innovation and digital design.

Moreover, there is a strong need to strengthen collaboration between academic institutions and heritage authorities. This partnership would enable the application of student-led research in real-world contexts, creating opportunities for experiential learning while directly contributing to heritage site revitalization. These collaborations could also serve as platforms for interdisciplinary cooperation, integrating the expertise of architects, historians, archaeologists, and interior designers to ensure holistic and contextually appropriate conservation efforts.

The integration of sustainable practices must also be prioritized in future heritage projects. This includes the use of eco-friendly materials, adaptive reuse strategies, and passive design solutions to ensure both environmental responsibility and cultural continuity. Digital heritage preservation methods such as 3D scanning, photogrammetry, and Building Information Modeling (BIM) are also recommended, as they enable precise documentation and simulation of existing structures, ensuring informed decision-making during conservation and reuse processes.

Furthermore, the study highlights the importance of expanding research in the field of heritage architecture, especially in understanding how historical buildings can be harmoniously integrated into modern urban environments. Emphasis should also be placed on continuous professional development,

through training programs and workshops for architects, designers, and conservationists. Keeping professionals up to date with international best practices and technologies is essential for maintaining high standards in the preservation of cultural assets.

Overall, these recommendations aim to reinforce the role of digital innovation, sustainability, and academic-industry collaboration in shaping a progressive, culturally grounded approach to heritage conservation—one that aligns with both educational goals and national development visions such as Saudi Arabia's Vision 2030.

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