

TOWARDS A DIGITAL DATABASE FOR RELIGIOUS HERITAGE: THE IBN KHALDOUN MOSQUE IN BÉJAÏA

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Abstract

The conservation of architectural heritage poses significant challenges for countries aiming to preserve their cultural identity and pass on their heritage to future generations while addressing contemporary issues. Architectural heritage is often represented by richly decorated, historically significant monumental buildings. Yet less visible, more modest buildings can also be important bearers of cultural values. Béjaïa was once a major commercial and intellectual crossroads in the Mediterranean. Rich in centuries-old heritage, some of its more discreet components are still poorly documented. The present study focuses on the Ibn Khaldoun Mosque, a building characterized by architectural sobriety and devoid of elaborate ornamentation or decorative complexity. Its importance lies not in aesthetic refinement but in historical continuity. In the absence of precise sources, this study takes a cross-disciplinary approach, combining historiographical research with digital technologies. It argues that documenting this historically rich heritage is essential for improving our understanding of cultural and architectural history. This work provides the first metrically precise, three-dimensional documentation of the mosque. This contribution is original in that it demonstrates the application of advanced digital techniques to modest heritage. The result is a precise and durable documentation that can serve as a basis for future architectural and structural studies.

Keywords: Ibn Khaldoun mosque; Casbah of Béjaïa; 3D laser scanner; Point cloud; Digital documentation

Introduction

The city of Béjaïa (Fig. 1) boasts a rich and varied architectural heritage: defensive buildings, mosques, cisterns, aqueducts, forts, and more. This diversity illustrates the city's rich history, the result of an evolution marked by the superimposition of several civilizations: Punic, Roman, Arab-Berber dynasties (Hammadids, Almohads, and Hafsids), Spanish, Ottoman, and French, all of which have left a visible mark on the architectural heritage of the city of Béjaïa.

The Casbah of Béjaïa is part of this heritage that has stood the test of time (Fig. 2). It is a fortress built on a steep part of the city; it overlooks the port of Béjaïa and has a breathtaking view of the Babor Mountains. This citadel is composed of several buildings, most of which had a defensive role, built at different historical periods to meet the needs of each occupier.

Inside the Casbah is the mosque, formerly known as Djamaa el Qasba; today it is known as the Ibn Khaldoun Mosque. It is considered the oldest building in the Casbah, along with the remains of the Hammadid ramparts.

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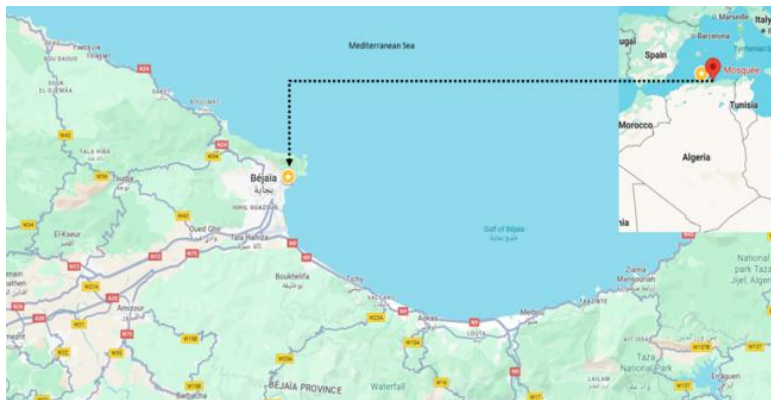


Fig. 1. Location of the city of Béjaïa



Fig. 2. Old picture of the Casbah (late 19th century)

Although Béjaïa is one of the richest cities in terms of Mediterranean heritage, we note that some of its historic buildings suffer from a lack of documentation and recognition. Many heritage buildings remain poorly studied or poorly documented. Like many historic cities, Béjaïa faces challenges such as the erosion of buildings, the neglect of ancient forms, and a lack of archives.

Faced with this deficiency, the use of digital technologies has emerged as a contemporary preservation method, enabling the restoration of the memory of places and promoting the enhancement of their heritage value. In this context, digital tools are not just an isolated technical solution but a lever for knowledge, transmission, and preservation of built heritage. Digital technologies, such as 3D laser scanning, now offer valuable tools for cataloguing, analyzing, and preserving these physical reminders of a city's history.

Technological advances have enabled rapid development in digitization since the mid-1990s. Many sectors, including city and network management, risk management and prevention, and cultural institutions, are increasingly using it, particularly for archaeological purposes such as preventive or planned excavations and diagnostics [1].

In 2003, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2003) promulgated the Charter on the Preservation of Digital Heritage, defining

digital preservation as the process of using digital technology to record, preserve, and access the cultural and historical values of historic buildings and sites [2].

The use of digital technology in heritage preservation offers key advantages, including the non-destructive nature of data acquisition [3], the convenience of data retrieval, and the authenticity of the preserved data [4].

The analysis of architectural design and the built environment, the overall management of the architectural heritage life cycle [5], and the identification of architectural pathologies [6]. These advantages translate into practical measures, such as the adoption of laser scanning and photogrammetry to document complex architectural details without causing physical damage to buildings.

To date, few studies have been devoted specifically to the Ibn Khaldoun Mosque. It is mentioned briefly in some works on the heritage of Béjaïa but has not been the subject of in-depth study. Nevertheless, it has only been examined in a limited and primarily descriptive manner within certain doctoral research (Azzoug thesis) [7]. It has also been the subject of an architectural study prior to a restoration and conversion project into a library carried out by a specialized firm (Atelier 3D), but this documentation remains limited to technical or functional considerations.

Although relevant on their own scale, these studies remain partial, often focusing on typology or state of conservation. They have highlighted certain architectural features of the building but have not provided an exhaustive study of its morphology. They focus either on general descriptive aspects or on proposals for reuse. We note that no digital approach has been used to date to document the building's morphology or analyze its state of conservation.

It is in this context that the present research project proposes a new approach to the Ibn Khaldoun Mosque: a multidisciplinary approach combining comprehensive three-dimensional acquisition using a 3D laser scanner (geometrically accurate and precise), historical contextualization, and heritage promotion.

In the absence of precise written sources and archives, a real heritage dilemma arises: how can we document, protect, and promote a little-studied religious building, using a combination of heritage history research and digital architectural survey tools? How can digital technologies such as 3D laser scanning contribute to the transmission, study, and preservation of a little-known heritage building such as the Ibn Khaldoun Mosque?

This article is based on a combination of two complementary perspectives: on the one hand, a historiographical reading aimed at placing the mosque in the urban and architectural context of the city of Béjaïa, and on the other hand, a digital study based on a 3D laser scanner survey, allowing for precise digital and geometric documentation of the building. The investigative logic of our research highlights the complementarity between history and digital technology, i.e., data collected in the field, particularly through digital surveying tools, can shed light on architectural history, especially when there is a lack of written and iconographic sources.

The use of 3D laser scanning thus makes it possible to go beyond the limits of traditional description by producing a faithful and measurable representation while serving as a basis for morphological and stylistic interpretation of the building. Consequently, tools from the fields of historical science, heritage architecture, and building technology have been implemented to contribute to a better understanding and recognition of this mosque within the Mediterranean heritage landscape. This research aims to link the city's prestigious past with the current need to preserve this heritage, demonstrating that technology is not a break with the past but a tool in the service of memory.

The Ibn Khaldoun Mosque in its historic setting: the Casbah of Béjaïa

The Casbah of Béjaïa is an ancient fortress (Fig. 3) located in the southwestern part of the city, next to Bab El Bahr (Saracen Gate or Sea Gate) and near Dar El Sinaa (a building for the construction and equipping of boats). It was built on a high plateau overlooking the sea from

a steep slope. It is rectangular in shape and covers an area of 2 hectares. The Casbah is surrounded by a thick enclosure wall with two monumental gates: the main gate leading to the city and the secondary gate overlooking the plains surrounding the city. It was defended by three very tall and massive towers, equipped with arrow slits; the one facing the city was razed during the bombings of 1853, along with the wall [8].

The Casbah contains several buildings: forts, a mosque, a house with a patio, a bakery built during the French colonial era, casemates, ruins of ancient Ottoman buildings, a stable, and five cisterns that can hold 200,000 liters of water [9].

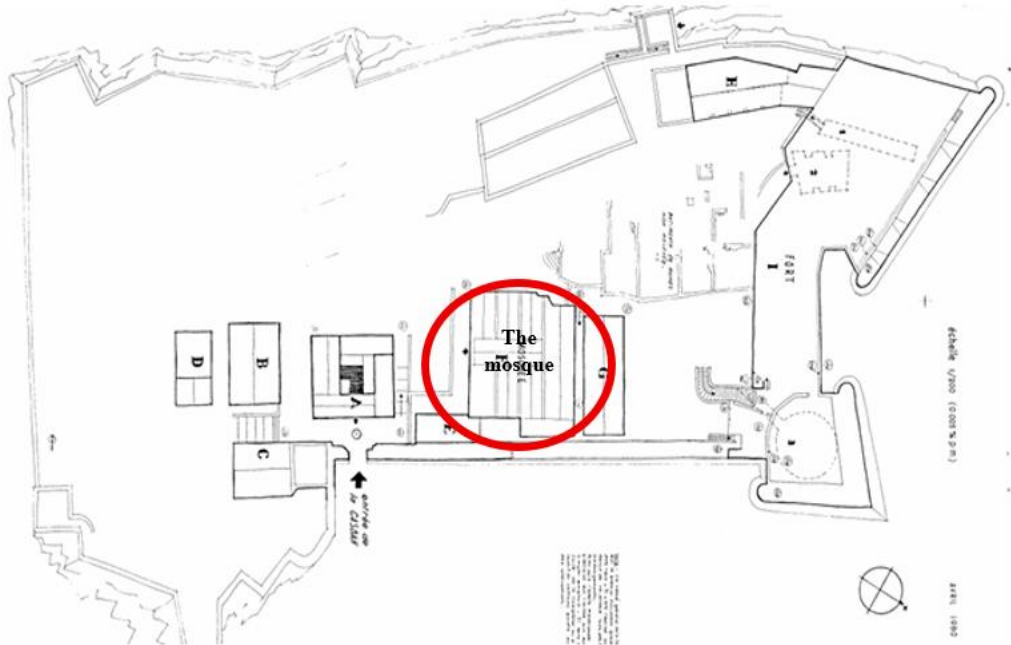


Fig. 3. Plan of the Casbah of Béjaïa

There are many differences of opinion among historians as to the origin of the Casbah of Béjaïa; some agree that it was built on the ruins of ancient buildings (built by Emperor Augustus in 33 BC) that protected the Roman port located in the nearby crevice and whose traces could still be seen in 1848, the traces of the mole, gradually buried by sand [8].

Féraud recounts that "the Casbah is built of reddish bricks, on the foundations of the fortified structure that was intended to protect the ancient port in Roman times" [10].

However, the occupation of the site of Béjaïa (Saldæ) dates back to a much earlier period. Historical and archaeological sources indicate the presence of Phoenician populations as far back as Antiquity, attesting to the antiquity of settlement in this strategic area of the Mediterranean coast.

As N. Carayon points out in his thesis, the Béjaïa agglomeration has been identified with Savlda in Strabo and perhaps with Sida in Pseudo-Scylax. Evidence of a Punic occupation consists of steles reported in the 19th century but which have never been found and the more recent discovery of a treasure trove of 2,671 Carthaginian coins dating from the last quarter of the 3rd century. While these findings suggest a Carthaginian presence in Salda at that time, there is no documentation of earlier periods [11]. Consequently, the thousand-year-old city of Béjaïa was one of Carthage's emporia.

In the 11th century, during the Hammadid period, the remains of the Roman ramparts were used to fortify the new Hammadid capital Enacirya [12], which corresponds to the western

wall of the current Casbah. These walls were built of stone with brick foundations and varied in thickness from 1.70 to 2.50 m [13].

According to Brunschwing, it was the Almohads who built the Casbah: "We must assume that this was their beloved system of a government citadel, attached to the city, with its independent organs: the Casbah of Béjaïa had its own mosque for khotba¹, just as the city had its own, important and beautiful, older mosque, the Great Mosque" [14].

According to De Beylé, the Casbah is a Spanish construction; in his book, he recounts how Pedro Navarro, who became master of the city of Béjaïa in 1510, abandoned the old Hammadid fortifications, which were too large for the forces at his disposal, and created new fortifications. Thus, was born the Casbah [15].

In his famous work "Kitab El ibar," Ibn Khaldoun recounts that he gave lessons in jurisprudence at the mosque of the Casbah during the Hafsid period, which means that it existed before the Spanish invasion [16].

According to this historical account, we can deduce that the Casbah was built during the Almohade period. However, the occupation of the Casbah site was preceded by several civilizations, as mentioned above. Subsequent civilizations benefited from its strategic location, which guaranteed the protection of the city and allowed for surveillance of external attacks coming from the sea.

Historical reconstruction of the Ibn Khaldoun Mosque

The mosque is located on the eastern side of the Casbah, perpendicular to the northeast rampart. The mosque is built on a fairly steep slope, so its western facade is largely buried, with only the upper portion rising above ground level.

There is some mystery surrounding the date of its construction. According to Azzoug's thesis, Casbahs did not exist in the Maghreb before the arrival of the Almohads. They are therefore considered a new architectural form that expresses the monotheistic doctrine preached by the Almohads, like the Casbahs of Tunis and Oudaya in Rabat. Among the most important buildings in the Casbah is the mosque, which bears the emblem of the Muslim nation and is a link between man and his Creator [7]. It plays a fundamental role not only in terms of functionality and social dynamics, but also in the urban landscape, as it is the ultimate landmark [17].

Most ancient books and historical writings agree that the mosque was built at the same time as the Casbah during the Almohad period in the 12th century, as it is assumed that the mosque of the Casbah is the same as the mosque mentioned in the context of Ali Ibn Ghanya Al Mayorqis' invasion of Béjaïa: "He advanced towards the Casbah and occupied it without a fight, planting his black flag there... then he headed towards the great mosque while the people were performing Friday prayers and surrounded them with his soldiers" [18].

Al Ghobri mentioned in his book "Unwan Eddiraya" about the scholars known in Béjaïa: Abdullah ibn Mohammed al-Ma'afari al Qala'i²: When he led the prayer on the 27th of Ramadan³ (Laylat Al Kadr), people liked to stand behind him because of his beautiful recitation, and Abu Abdullah ibn Mu'min, the governor of Béjaïa at that time, used to attend the prayer on the 27th, which was held in the mosque of the Casbah [19].

The mosque seems to date back to the Almohad period, as evidenced by certain historical writings and its location within the medieval Casbah. However, Laurent Charles Féraud mentions in his book "Histoire de Bougie" that the building underwent reconstruction during the Ottoman period, which explains the predominance of elements typical of this phase in its current configuration [10].

¹ Refers to the sermon, or preaching, delivered during Friday prayers (Salat al-Jumu'ah) and the two Eids (religious holidays).

² A well-known jurist in Béjaïa at the seventh century AH.

³ Ramadan is the ninth month of the Islamic lunar calendar, characterized by daily fasting from dawn to sunset, prayer, and spiritual reflection.

Today, only a few vestiges of the original (Almohad) structure remain, difficult to identify but integrated into the existing building, bearing witness to the historical stratification and successive reuse of the mosque site.

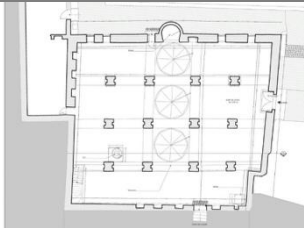
Ibn Khaldun, a major figure in historical and sociological thought, was one of the personalities who frequented the Casbah Mosque, thereby lending it particular importance, as well as intellectual and symbolic value. According to historical sources, Ibn Khaldun taught jurisprudence at the mosque. This scholar's presence links the mosque to the vast intellectual heritage of the medieval Maghreb, where material and immaterial heritage converge.

In his book "Kitab El ibar," he said of his emir Abd Allah Mohammed El Hafsi, "He introduced me to preaching at the mosque in the Casbah, and after I left the management of the kingdom, I devoted myself to teaching knowledge during the day at the mosque in the Casbah, and I have not stopped doing so" [16].

Architectural analysis of the Mosque

The mosque is designed according to a rectangular layout measuring 19.35 m in length and 16.54 m in width. Its surface area is 320.05 m². The Ibn Khaldoun Mosque has certain atypical features that enhance its architectural and heritage value. Unlike the most common models seen in religious architecture, the building has neither a Sahn (central courtyard) nor a minaret, two elements usually associated with mosques. However, one remarkable feature has been identified: a water cistern located under the prayer hall. (It is believed to date from the Roman era). Table 1 summarizes the main architectural features of the mosque and highlights their function, heritage value, and architectural influences.

Table 1. Architectural features of the mosque

Architectural description	Analysis and interpretation	Photo
The prayer hall has a hypostyle layout with five naves perpendicular to the qibla wall and four bays parallel to the qibla wall (Fig. 4).	The central nave, which is the widest, is topped by three octagonal domes and corresponds to the mihrab aisle. The central nave is highlighted.	 Fig. 4. The plan of prayer hall
It is a niche carved into the wall of the qibla (Fig. 5); it stands out in the middle of the elevation in the form of a semi-cylindrical protrusion topped by a dome. The mihrab is crowned by a horseshoe arch topped by a rectangular frame. These rest on two columns of marble.	It is simple, with no decoration, because it was demolished during the French colonial period and replaced with a door.	 Fig. 5. The mihrab of Ibn Khaldoun Mosque
To the right of the mihrab is a recess in the wall that is 0.95 m wide, 0.50 m deep, and 2.50 m high; this is the location of the minbar (Fig. 6).	The original minbar no longer exists, because the mosque underwent several changes of function during the Spanish and French occupations.	 Fig. 6. The minbar

They cut across the longitudinal space perpendicular to the naves. They are oriented east/west (Fig. 7).

These elements served a structural purpose: they contained the lateral thrust exerted by the arches.



Fig. 7. Position of wooden tie beams

Pointed horseshoe arch:
This type of arch is found in all the naves except the central nave (which leads to the mihrab). There is a longitudinal rib that divides the arch into two parts. There are twelve arches, which rest directly on the pillars (Fig. 8).

In the central nave, the structural complexity and ability to distribute thrust of the polylobed arches are combined with the classical stability of the semicircular arches to provide solid support. This technical harmony between the two arch types provides effective support for the domes above the nave, ensuring the stability of the structure and enhancing the interior aesthetics.



Fig. 8. Pointed horseshoe arch

Semicircular arch:
In the prayer hall, there are six of these arches in the first, second, and third bays (Fig. 9).



Fig. 9. Semicircular arch

Many authors claim that it was demolished during the French colonial era. There are two versions as to its position in the mosque:

- 1- It was located in the northwest corner of the mosque near the rampart, as traces of excavations have been found on this side of the wall, as well as traces of stairs believed to lead to the minaret (Fig. 11)



Fig. 11. Traces of stairs

The Ibn Khaldun Mosque does not have a minaret.

- 2- During excavations at the mosque site, archaeologists found a fragment measuring 1.30m wide and 3.57m long on the southwestern wall, believed to be the former location of the minaret (Fig. 12).

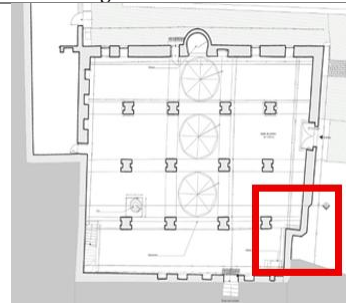


Fig. 12. Split in the south-west wall

During the French colonial period, the mosque had a gable roof composed of two triangular gables supported by a two-slope roof structure. The roof was covered with tiles (Fig. 13).

Following restoration work in the 1990s, the mosque was returned to its original state, with three octagonal domes covering the central nave (Fig. 14).

The roof was modified during the French period to reflect a desire to impose a more Western-style architectural approach: concealing the domes, a symbolic element of Islamic architecture, undermined the monument's spiritual and visual identity.

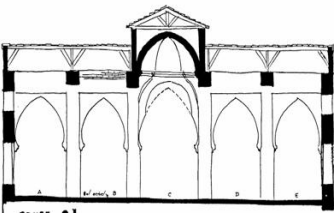


Fig. 13. The roof during the French colonial period



Fig. 14. The roof's current state

The mosque in the Casbah is devoid of any decoration, whether geometric, floral, or calligraphic. The only exceptions are the simple moldings at the base of the domes and on the pendentives (Fig. 15).

The absence of decoration makes it impossible to determine the architectural style with certainty, which is why we rely on architectural elements. The mosque is characterized by its pure, sober, and modest decoration, which avoids any excessive luxury or ostentatious ornamentation that might distract the attention of the faithful.



Fig. 15. The simple moldings at the base of the domes

Located under the prayer hall, the cistern (Fig. 16) is used to store rainwater collected from the mosque's roof via terracotta canals (Fig. 17). It is believed to date back to the Roman era and has several water inlets. The cistern is made up of two chambers covered by barrel vaults and has a capacity of approximately 50 m³.

The position of the cistern beneath the prayer hall is unusual and inappropriate in terms of the traditional mosque layout. We therefore assume that the mosque was relocated or reorganized during its reconstruction in 1797 in the Ottoman period.



Fig. 16. The cistern



Fig. 17. The terracotta canals

It is located on the west wall of the mosque and is used as a prayer space for women.

During the colonial period, the interior of the prayer hall was divided into two levels. Evidence of this transformation can be seen in the twelve corbels (Fig. 18) on the north and south walls, which supported an intermediate floor. The upper part of this floor was probably used to store weapons, reflecting a functional reallocation imposed by the occupiers that altered the mosque's original configuration. This mezzanine is currently used as a prayer space for women (Fig. 19).

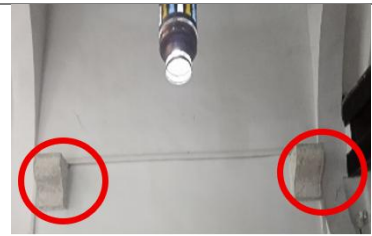


Fig. 18. The corbels



Fig. 19. The mezzanine

Analysis of the elevation

The mosque is a simple, solid, cubic structure. Its few, relatively narrow openings are arranged vertically and take the form of sober, unadorned semi-circular arches. These openings help to regulate the interior lighting, providing a true architectural translation of functional and spiritual requirements. The white color of the façades accentuates the dominance of the full over the empty, creating the impression of a monolithic mass. On the eastern façade, the mihrab stands out with its semi-cylindrical projection, indicating the direction of prayer. The north and west façades are partially buried, leaving only the upper part visible and thus reinforcing the building's compact and discreet character.

The main door, located on the south façade (Fig. 20), is notable for its monumental character. Made of wood, its horseshoe arch has a steeper curve than the traditional semi-circular arch, giving the entrance a slender, refined appearance. The arch is framed by a rectangular coping, known as an alfiz, which highlights the clear, structured geometry of the composition.



Fig. 20. The south façade

Historical evolution and transformation

Almohad period

The mosque was constructed within the Casbah during the Almohad period.

Spanish period

Following the Spanish invasion, palaces and mosques were pillaged as part of the efforts to establish Christian rule and evangelize the region. During this period, the Casbah was known as the “Great Castle.”

Ottoman period

According to Laurent Charles Féraud, the mosque located within the Casbah, known as the Great Mosque, was rebuilt by order of Mustapha Pasha in 1797–1798, following the damage and alterations it had likely undergone during the Spanish period [10].

French period

On November 17, 1903, the mosque was classified as a historical monument by order of the Governor General of Algeria.

After consulting the archives of the Château de Vincennes [24] and historical accounts, it appears that the French reassigned the mosque to several functions:

- In 1834, the mosque served as a hospital.
- In 1836/1837, it became a barracks for officers and non-commissioned officers with a capacity of 95 men; during this period, a proposal was made to add another floor to accommodate 190 men.
- In 1849, the mosque was assigned to the subsistence service.

From an architectural point of view, the Ibn Khaldoun Mosque underwent many changes during the years of French colonization: the mihrab was demolished and replaced by an entrance door, and the domes of the central nave were covered by a double-sloped wooden frame. The south, north, and east facades underwent visible transformations, notably with the addition of several windows to improve interior lighting.

At the same time, some wall niches dating from the Ottoman period were blocked off, partially erasing the original decorative or functional elements to adapt the space to new uses.

As for the interior space, an access point was created between the mosque and the building located on its west side (thatched huts for 30 men), the height of the mosque was raised, and an intermediate wooden floor was added.

After independence

The Casbah of Béjaïa was classified by the Algerian government⁴. After independence, the mosque fell into oblivion, subject to the ravages of time in the same way as the Casbah.

UNESCO has devoted several studies to it. In the 1990s, the mosque underwent architectural restoration to its pre-colonial French period and structural reinforcement by a specialist firm in order to be reallocated as a library.

On March 11, 2024, it resumed its original function as a place of worship during the holy month of Ramadan.

Architectural survey using 3D laser scanning, point cloud acquisition and processing

The digitization of built heritage is a modern method of identifying, protecting, conserving, restoring, disseminating, and transmitting data on monuments and built heritage to future generations.

This digitization has a major advantage, as digital copies of monuments (called digital twins) can be stored long-term at low cost and used many times for various purposes. The use of 3D scans in the reconstruction of Notre-Dame Cathedral in Paris (France) after its fire in 2019 is a very significant example [20].

In order to document the Casbah Mosque accurately, a three-dimensional survey was carried out using a 3D laser scanner. The aim of this approach is to produce a faithful digital database, enabling both rigorous conservation of spatial data and in-depth analysis of the

⁴ Ordinance No. 67-281 of December 20, 1967, published in the Official Journal No. 7 of January 23, 1968.

existing building. It is part of a contemporary approach to heritage, combining technology, historical interpretation, and visual documentation.

Materials and methods

The three-dimensional survey of the mosque was carried out using a FARO Focuss terrestrial laser scanner (Fig. 21), a high-precision device specifically designed for architectural and heritage documentation. This scanner captures the built environment by laser scanning, generating a dense point cloud with a range of up to 70 meters outdoors. The scanner measures 360 degrees horizontally and 300 degrees vertically. The method used is based on a station-by-station survey, with controlled overlaps to ensure a rigorous connection between the scans.



Fig. 21. FARO Focus terrestrial laser scanner

The total digitization of the mosque required 50 color scans with a point cloud density of 43.7 million, which indicates the number of points captured by the scanner during a full 360° scan. The higher this number, the denser the point cloud, producing a better representation of the scanned scene. Accuracy is plus or minus 1 mm. We used a quality (this is related to the number of repeated measurements per point to reduce noise and improve accuracy) of 4x, which means that each point is measured four times. The scanner is also equipped with a camera that allows for 3D photographic surveys. This approach made it possible to capture the entire interior and exterior volume of the building.

The 3D scanning of the mosque took two days of work, which is approximately equivalent to 14 hours of scanning time, with each measurement point taking an average of 7 minutes to scan.

A station positioning strategy was developed in advance before beginning the survey (Fig. 22), starting with the exterior of the mosque and then moving on to the interior:

- In the first stage, we scanned the exterior of the mosque. Starting at the south corner of the east facade, we then scanned the entire east facade. We then returned to the south facade,

followed by the west facade and finally the north facade, where we encountered some access difficulties because the north rampart and the imam's private space are attached to this part of the mosque.

- In the second stage, we scanned the roof. The stations were positioned around the perimeter, along the parapet, following a circular path around the roof.
- In the third stage, we moved on to the interior of the mosque. The station was placed next to the mihrab in the central nave, and the scanner was positioned first in the nave to the right of the mihrab and then to the left.
- Finally, we scanned the mezzanine, which is currently used as a prayer space for women.



Fig. 22. Station positioning strategy

Once the survey was completed on site, 8.33 GB of raw data from the various stations was assembled using FARO SCENE software (Fig. 23), allowing the scans to be automatically aligned by geometric correspondence. The point cloud thus obtained provides a complete and accurate model of the mosque, with an average level of precision equivalent to 2 mm, reproducing the smallest architectural details: the curves of the vaults, the irregularities of the walls, and the recesses.



Fig. 23. Stage of assembling the scans of the mosque

The processing also includes a cleaning phase (removal of extraneous data related to visitors, furniture, and vegetation), followed by optimization of point densities according to areas of interest.

Results and discussions

Ultimately, the scan of the Ibn Khaldoun Mosque generated a point cloud composed of 819,669,475 points (16 GB) (Fig. 24). This point cloud constitutes a high-precision digital archive that can be reused at different scales (elevation, plan, and section) and provides an accurate reading of the building in its current state.



Fig. 24. Ultimate point cloud

It should be noted that we encountered certain constraints during the digitization campaign, such as difficulty accessing the northern part of the mosque due to its configuration (adjacent to the northern rampart of the casbah and the imam's chamber), as well as the flow of worshippers during prayer times, which required us to adapt our survey schedule in order to respect the religious function of the site.

Conclusion

Heritage sites are undoubtedly under constant threat from a variety of risks, such as climate change causing natural disasters and increasing deterioration; also, development pressure, uncontrolled tourism, pollution, poor site management, negligent rehabilitation/maintenance interventions, looting, etc. [21].

The use of 3D laser scanning techniques has profoundly revolutionized surveying, modeling, and analysis procedures. These technologies enable complex structures to be recorded remotely, efficiently, and accurately, which would not have been possible with previous survey methods. They make a significant contribution to the fields of architectural study, conservation, and restoration, as they enable the current state of buildings to be recorded using efficient, rapid, non-invasive, and, above all, highly accurate techniques [22].

The combination of 3D digital data and *in situ* observations allows us to identify deterioration, subsidence, cracks, gaps between elements, etc.

By combining the results of 3D surveys with current digital tools, it is now possible to carry out more in-depth analyses by generating an HBIM (Heritage Building Information

Modeling) model of the building, which can be used to support detailed structural studies and to plan restoration and consolidation work.

These technologies not only streamline inventory processes but also improve the quality of cultural heritage protection, serving as an indispensable tool in heritage management. Compared to traditional methods, digital technologies offer significant time and cost savings while maintaining high measurement accuracy.

These technologies also enable the creation of digital archives of details, which can be used in the future to reconstruct damaged elements [23].

The study conducted on the Ibn Khaldoun Mosque demonstrates the value of a cross-disciplinary approach combining historical analysis and digital surveying for the documentation and understanding of a religious building that has been little studied to date. In the absence of precise written sources and faced with silent archives, the use of 3D laser scanning has provided a reliable geometric database, conducive to a detailed architectural reading and an initial form of scientific evaluation.

This approach, which is both respectful of the site's religious function and rigorous in terms of methodology, now opens the way for further expansion. The processing of the point cloud will feed into the construction of an HBIM (Historic Building Information Modeling) model, enabling more systematic management of heritage information and in-depth structural analysis, particularly through digital simulations focused on studying the mechanical behavior of the building.

Thus, beyond its exploratory dimension, this research work is intended as a first step towards better integration of digital tools in the study of heritage, particularly for modest or forgotten buildings that nevertheless bear complex and revealing historical layers.

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