

From Open Courtyards to Enclosed Sanctuaries: A Methodological Approach to the Assessment of Ablution Spaces in Marrakech's Religious Complexes

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This study explores the architectural and functional evolution of ablution spaces in the historic mosques of Marrakech, from the 12th century to the present day. Focusing on mosques from the Almoravid to Saadian periods, it examines how these spaces transitioned from open-air communal water features to enclosed, technologically advanced environments. By comparing the design and functionality of ablution spaces across different eras, the research highlights the interplay between theological principles and architectural adaptations. The study collects detailed spatial and structural data through on-site photography and 3D scanning, creating high-resolution models of these spaces. This material is analyzed to assess the condition of ablution areas, their integration within mosque layouts, and the balance between historical authenticity and modern functional needs. The findings aim to identify urgent preservation priorities and propose restoration strategies, contributing to improved water-related heritage management within Islamic architecture. Ultimately, this study provides valuable insights into preserving traditional elements of Islamic architecture while adapting them to contemporary demands, ensuring that their historical and cultural significance remains intact.

Key Words: 3D scanning, architectural conservation, Islamic architecture, ablution spaces, Marrakech mosques, heritage preservation

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INTRODUCTION

[368] Marrakesh, an ancient city of profound historical significance, stands as a testament of cultural and architectural heritage in the Islamic world. Its foundation and development were not arbitrary; rather, they were strategically planned, shaped by the city's advantageous geographic location, its abundant natural resources, and favorable environment, which together made it an ideal center for settlement and governance. Over the centuries, Marrakesh became a melting pot of diverse influences, with each ruling dynasty leaving its mark on its landscape, most notably through its religious architecture. These structures, often situated at the very heart of the urban fabric, are more than mere places of worship – they are living monuments that encapsulate the architectural and urban planning wisdom of the eras in which they were constructed. Among the various elements that define Islamic architectural design, the ablution spaces within Arab mosques hold particular significance. Traditionally, these areas were communal spaces where worshippers gathered to perform ritual purification before entering the prayer hall. This ritual, while deeply spiritual, also fulfilled a social function. In contrast to the prayer hall, where silence is observed, ablution spaces allowed conversation and interaction among the faithful, reinforcing the communal dimensions of Islamic worship.

This paper examines the significance of ablution spaces within the mosques of Marrakesh, focusing on how they were incorporated into the overall mosque layout and how their design evolved from the Almoravid era onward. Through a detailed analysis of specific examples in Marrakesh's historic religious buildings, the study sheds light on their architectural organization, the intricate water systems that supported them, and the canalization techniques employed. This exploration highlights not only the functional aspects of these spaces but also their importance within the broader context of Islamic architectural heritage.

BACKGROUND INFORMATION

Founded in 1070 by the Almoravid dynasty, Marrakesh rapidly emerged as a major political, economic, and cultural center in the Islamic West. The city's architectural landscape reflects the influences of various dynasties, with religious complexes serving as some of the most enduring symbols of its rich and diverse heritage. These complexes, which include mosques, madrasas, zaouias, and public baths, were integral to



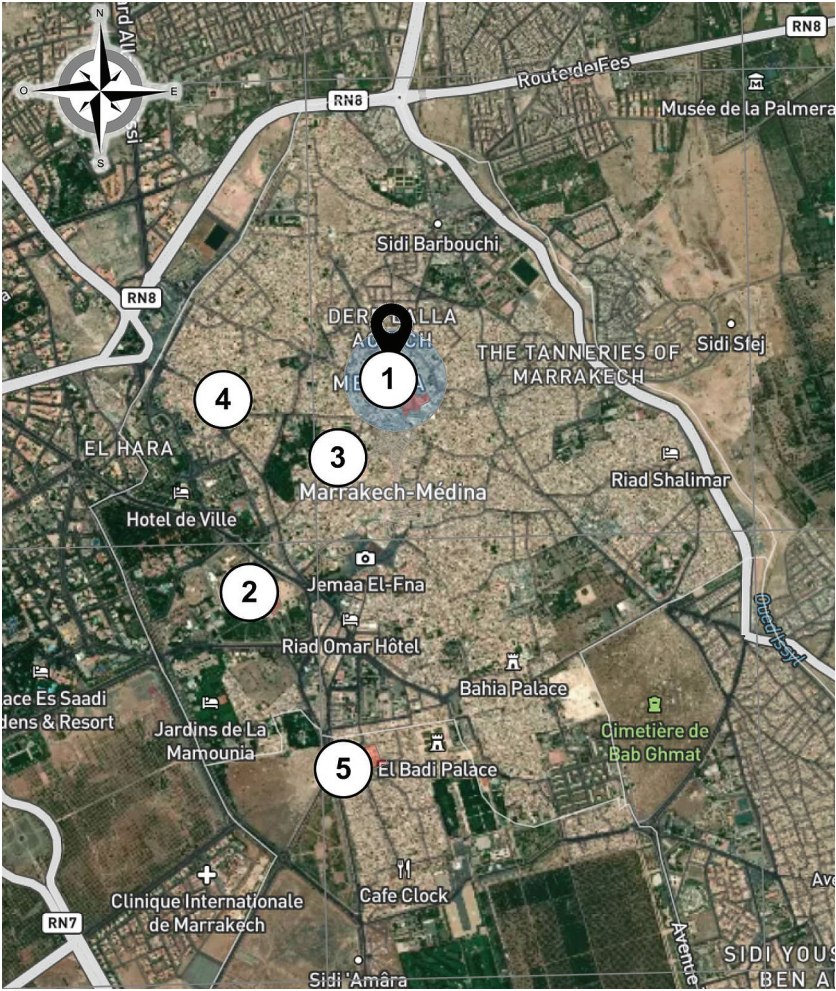


FIGURE 1 Map of the Different Religious Complexes of the Medina of Marrakesh

the spiritual, educational, and social life of the city, as illustrated by their distribution in the map of the medina in figure 1.

Many religious complexes form an essential part of Marrakesh’s urban landscape, both historically and today, with several still preserving one or more components of their original structures.

The Ben Youssef Complex

The Ben Youssef complex, originally established during the Almoravid period, includes the Ben Youssef Mosque and the Ben Youssef Madrasa,

[370] once the largest Islamic college in North Africa. This complex reflects Almoravid and Saadian influences in its architectural design, featuring a central courtyard adorned with fountains that served ablution needs. It functioned as a vital center for both religious practice and education, reinforcing its role as a cornerstone of the community's spiritual and intellectual life (Ecochard and Deverdun 1952).

The Kutubiyya Complex

One of Marrakesh's most iconic religious complexes is the Koutoubia, constructed in the 12th century under the Almohad Caliph Yaqub al-Mansur.

Renowned for its towering minaret, the complex exemplifies Almohad architectural principles such as simplicity and geometric precision. Serving as a center for both worship and learning, the complex's design influenced later Islamic architecture in the region, particularly in its spatial organization and integration of various religious functions (Bloom 2000).

The Mouassine Complex

The 16th-century Mouassine complex, developed under the Saadian dynasty, is a prime example of integrated religious architecture in Marrakesh. It includes a mosque, madrasa, library, and hammam, all arranged around a courtyard designed for communal use. The Saadians emphasized the revival and enhancement of earlier Islamic traditions, as seen in the intricate tilework and carved stucco that adorn the complex, blending functionality and aesthetics seamlessly (Marçais 1926).

The Bāb Dukkāla Complex

The Bāb Dukkāla religious complex in Marrakech was constructed during the reign of Sultan 'Abdallāh al-Ghālib (1557–1574), with significant contributions attributed to al-Mansūr's mother, al-hurra Mas'ūda. The mosque, completed around 1557–1558, was endowed with a substantial charitable trust (*waqf*) that included shops, houses, water sources, and cultivated land, ensuring complex's financial sustainability. At its core is a congregational mosque, surrounded by various facilities such as an ablution pavilion, a Qur'anic school, and commercial spaces that contributed to the social and economic vitality of the neighborhood (Almela 2019).



The Qasba Complex

Located within the fortified Qasba district, the Qasba complex was constructed by the Almohad Caliph Yaqub al-Mansur in the late 12th century and served as both a religious and political center. Its monumental mosque, characterized by an austere architectural style, reflects the Almohad emphasis on purity and simplicity. As a hub for both worship and governance, the Qasba complex symbolized Almohad authority and played a crucial role in the political and religious life of the city (Bloom 2000). [371]

LITERATURE REVIEW

Ablution Spaces in Islamic Religious Architecture

The existing literature on Islamic architecture has extensively explored various elements that define its aesthetic and functional principles, with particular attention given to the significance of ablution spaces within religious complexes. Scholars such as Oleg Grabar (1987) and Robert Hillenbrand (1994) emphasize the importance of these spaces not only in ritual practice but also in the architectural organization of mosques. Ablution areas are understood as critical components that reflect broader Islamic values of purity, community, and spiritual preparation. As noted by Nasser Rabbat (1994), the design of these spaces embodies a deliberate integration of form and function, ensuring that the ritual of purification is seamlessly incorporated into the worshippers' experience. Studies on the evolution of Islamic architectural practices further highlight how ablution spaces have adapted to diverse regional and historical contexts, maintaining their essential religious role while also reflecting local architectural innovations and technological advancements in water management (Hill 2009).

Historical Studies on Marrakesh Monuments

Although there is a substantial body of scholarship on Islamic religious architecture overall, detailed studies on Marrakesh remain relatively limited. Research often highlights the city's rich architectural heritage as a crossroads of Almoravid, Almohad, and Saadian influences, yet comparatively little scholarly attention has been devoted specifically to the study of ablution facilities within its monuments. This gap is particularly notable given Marrakesh's historical importance as a capital and religious center, where mosques and madrasas were equipped with highly developed hydraulic systems.

Digital Tools for Heritage Documentation

[372] Recent studies in the field of heritage documentation underscore the potential of digital technologies such as photogrammetry and 3D scanning for recording fragile or inaccessible spaces. These methods allow for the detailed visualization of ablution areas and water systems, supporting both historical interpretation and conservation planning. By combining historical scholarships with digital reconstruction, researchers can generate new insights into the architectural logic and material condition of spaces that have traditionally received little attention.

Conservation Approaches and Challenges

The literature also emphasizes the symbolic and functional importance of water in Islamic religious contexts, where it represents purity and life (Grabar 1987). Historic mosques often incorporated advanced hydraulic systems to ensure the constant availability of clean water for ritual purification. Yet despite broader research on water management in Islamic urbanism and architecture (Hill 2009), focused studies on how these systems were implemented in Marrakesh's mosques remain scarce.

Addressing this gap is essential for understanding how sacred spaces functioned historically and how their water systems supported religious practices within the specific environmental and cultural conditions of Marrakesh. Moreover, such investigations provide a foundation for developing conservation strategies that preserve not only the material remains but also the intangible ritual functions of these ablution spaces

THE ORGANIZATION OF PLACES OF WORSHIP BEYOND THE MOSQUE

A religious compound is typically defined as a bounded area that contains multiple buildings or facilities that serve religious functions, such as a mosque, *medersa* (Islamic school), and spaces for rituals like ablutions. A key element within these structures is the ablution space, which is essential for the ritual purification required before prayer. These areas are strategically positioned within mosque complexes, reflecting the Islamic emphasis on cleanliness and spiritual readiness. In mosques such as the Koutoubia and Ben Youssef, ablution spaces are thoughtfully integrated to facilitate seamless access, highlighting their



significance in both the physical and spiritual preparation of worshippers.

Ablution spaces, known as *wudu* areas or as *mida'a*, are central to Islamic religious practice, serving as essential sites for the ritual purification required before performing *salat* (prayer) (Khan 1997). These spaces go beyond their functional role as mere areas for physical cleansing; they are imbued with spiritual significance, representing the preparation necessary to achieve a state of purity before engaging in prayer. The ritual of ablution, which involves washing specific parts of the body – such as the hands, face, arms, and feet – symbolizes the purification of both body and soul from impurities, thus aligning the worshiper with the inner purity emphasized in Islamic teachings (Esposito 2005). These spaces often feature centrally placed water elements, such as fountains or basins (Grabar 1987).

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HISTORICAL CONTEXT

Evolution of Mosque Architecture and Water Management from Almoravid to Saadian Eras

During the Almoravid period (1040–1147), the foundations of Marrakesh's architectural identity were established, characterized by the construction of monumental mosques that incorporated simple, yet effective water management systems designed to support communal ablution practices. The Almoravids, known for their austere and functional approach to architecture, emphasized the essential role of water in ritual purification, integrating basic yet strategically placed water features – such as courtyard fountains – into mosque designs (Meunier 1957). As the city transitioned into the Almohad era (1147–1269), there was a noticeable shift toward more complex architectural forms and more advanced water management systems. The Almohads introduced innovations such as expanded ablution spaces and increasingly sophisticated hydraulic technologies, which allowed for more efficient water distribution and use within the mosques. This period saw the construction of the Koutoubia Mosque, where the integration of water management became more advanced; one notable example is the hydraulic mechanism that enabled the movement of the mosque's Minbar (Almagro and Jiménez 2022; Ettinghausen 1976; Bloom 2000). The Saadian era (1549–1659) brought further advancements in mosque architecture and water systems, exemplified by the construction of the Mouassine Mosque complex. The Saadians, known for reviving earlier

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Islamic architectural traditions, expanded upon the water management techniques of their predecessors by incorporating elaborate fountains, cisterns, and underground channels. The Saadian contributions represent a culmination of the evolving architectural and technological practices that began with the Almoravids, demonstrating a deepening understanding of the relationship between water, space, and religious ritual in Islamic architecture (Terrasse 1957).

Historical Water Supply and Distribution Systems in Marrakech

The ancient medina of Marrakesh features a sophisticated water distribution system that played a central role in its urban and architectural development, particularly in the context of religious buildings such as mosques. At the core of this system were the khetaras, a network of underground channels that transported water from distant sources in the Atlas Mountains to the city. These channels, ingeniously designed to harness gravity, ensured a steady and reliable supply of water to Marrakesh, even during periods of drought (El Faïz 2001).

This system was expanded during the Saadian era under Sultan Abdallah, who significantly increased the amount of water brought into the city, including the delivery of drinking water through these canals (Almela 2019; Wilbaux 2001).

Design and Function of Water Canalization in the Selected Mosques

Upon reaching the city, water was distributed through a network of seguias, open-air canals that directed the flow to various parts of the medina, including residential areas, public fountains, and religious sites. Within mosques and other buildings, water was further managed and stored using the maada system, consisting of reservoirs and cisterns that accumulated water for later use. This infrastructure supported daily activities and religious rituals such as ablutions, playing a crucial role in maintaining both hygiene and the spiritual sanctity of these sacred spaces (Deverdun 1959). The integration of these water distribution mechanisms demonstrates the advanced hydraulic engineering of the period and emphasizes the period of water in sustaining the spiritual and communal life of Marrakesh's historic urban period.

Integration of These Systems into Overall Mosque Architecture

Within the mosque, the water is distributed from the hydraulic systems to storage reservoirs and from there to ablution fountains and basins, often located in the courtyard or adjacent to the prayer hall. These foun-



tains, typically the focal point of the ablu-tion area, are designed to accommodate multiple worshippers at once, providing a continuous supply of water through carved spouts or taps. The design of these ablu-tion facilities is both practical and symbolic: they facilitate the ritual cleansing process while also embodying the Islamic emphasis on purity and cleanliness. This integration of hydraulic engineering and religious architecture reflects the ingenuity with which Islamic societies designed their sacred spaces, ensuring that the act of purification remained both accessible and spiritually meaningful for all worshippers. [375]

METHODOLOGY

Detailed Explanation of On-Site Data Collection Techniques

Our study’s methodology for analyzing these ablu-tion spaces is structured around three key elements, as shown in figure 2 of methodol-ogy schema. First, we selected buildings from three distinct contexts to enable comparative analysis: a separate ablu-tion space (the Almoravid Qubba), an ablu-tion space within a medersa (Medersa Ben Youssef), and an ablu-tion space integrated within a mosque (the mosque annexed to the mausoleum of Sidi Abdelaaziz Tebbaa). This selection al-lows us to examine how ablu-tion spaces are integrated across different architectural settings, how their design varies according to context, and how they functionally and architecturally relate to other components of the religious complexes. Second, we defined a data collection strat-egy aimed at assessing the condition of these spaces. For this study, we employed both photogrammetry and 3D LiDAR scanning. These tech-niques allowed us to evaluate the effectiveness of preservation efforts in maintaining the structural and material integrity of the sites.

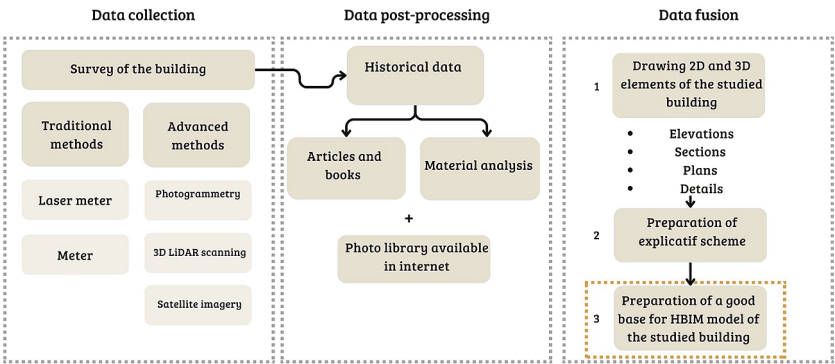


FIGURE 2 Schema of the Study Methodology

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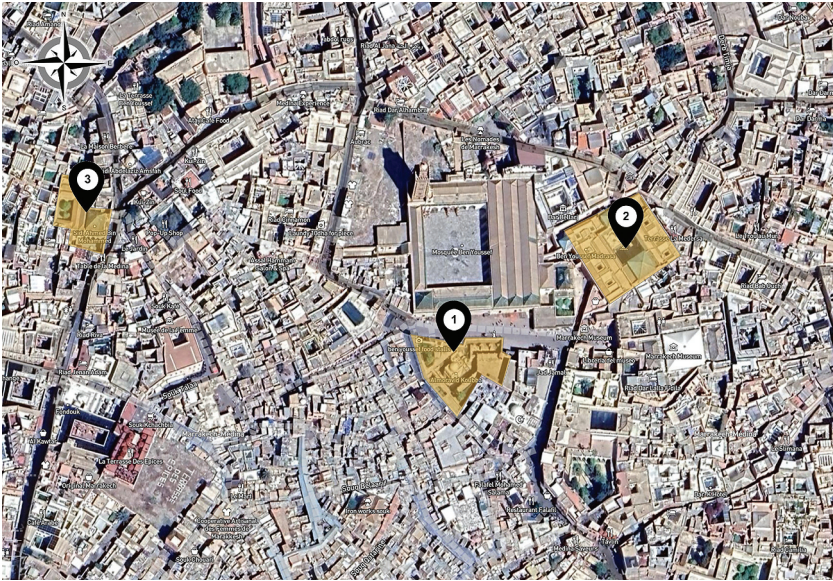


FIGURE 3 Map of the Ablution Spaces Examined in This Study

Finally, the third element of our methodology involves data post-processing. We utilized the scans and photographs collected to create detailed reconstructions of the ablution spaces. This process included an assessment of preserved materials and water systems, analyzing how these systems function and supply the spaces, thereby providing insights into both their historical and contemporary significance.

This selection was based on three main criteria: (1) their representativeness of different periods and typologies in Marrakesh's religious architecture (Almoravid, Saadian, and post-Saadian contexts); (2) the presence of distinct and still-identifiable ablution facilities, whether integrated or designed as annexes; and (3) their accessibility for documentation and digital surveying, enabling a detailed comparative analysis. Together, these sites, as shown in the map in figure 3, provide a diachronic perspective on the architectural evolution and functional integration of ablution spaces within religious complexes.

Contextualization of Ablution Spaces for the Study Case

The Almoravid Qubba The Almoravid Qubba (figures 4.1, 4.2, and 4.3), dating back to the 12th century, is a rare surviving example of Almoravid architecture and was likely part of a larger religious complex.





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FIGURE 4 Images from the Ablution Spaces and Their Water Infrastructure in the Case Study Complexes

NOTES 1. The Qubba above the fountain of the Almoravid Qubba; 2. Fountain of The Almoravid Qubba; 3. Ruins of the ablation spaces surrounding the Qubba Almoravid. 4. Fountain of the ablation space in Ben Youssef Medersa; 5. Central courtyard basin of the medersa (decorative today, formerly used as an ablation area). 6. The Muqarnas qubba above the fountain in the ablation space of Ben Youssef Medersa; 7. The fountain of the mausoleum of Abd El Aziz Tebbaa. 8. The fountain of the ablation space/courtyard inside the Abd El Aziz Tebbaa mosque.

Featuring a dome and an advanced water system, the structure may have been integrated into a broader complex that included a mosque and a madrasa, serving as an important site for ablution and other religious practices. The Qubba's sophisticated water distribution system reflects the technical achievements of Almoravid engineering and its pivotal role in the ritual purification process (Meunié 1957).

The architectural form of a *Qubba* is traditionally associated with *zaouias* or tombs, often serving as a mausoleum or a shrine for venerated religious figures in Islamic architecture. However, the Almoravid *Qubba* in Marrakesh represents a notable departure from this conventional function as a tomb, this Qubba was designed as an ablution facility, dedicated to the ritual purification of worshippers in a space separate from the main mosque. Its purpose was to provide a covered, ar-

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chitecturally significant space where worshippers could perform *wudu* (ablutions) before entering the mosque for prayer (Rose-Albrecht 2018; Tabbaa 2008). As Almela (2019) notes, this Qubba represents one of the most exceptional examples of a *mida'a* designed as an annex in religious complexes.

Medersa Ben Youssef Within the religious and educational complex of Ben Youssef (figures 4.4, 4.5, and 4.6), the ablution space is strategically positioned adjacent to the mosque area to facilitate the ritual purification required before prayer. These spaces are designed with both privacy and communal use in mind, integrating traditional elements such as a central fountain and basins that blend seamlessly into the courtyard's layout. The ablution area is situated in the northeastern part of the mosque, chosen for both accessibility and discretion. This enclosed space is crowned with a dome, which enhances its sacred atmosphere, and features ablution boxes arranged around a central fountain.

Mosque of Sidi Abd el Aziz Tebbaa The Zaouia of Sidi Abd el Aziz Tebbaa includes a mosque, a madrasa, and a mausoleum dedicated to the prominent Sufi figure. This complex exemplifies the close integration of spiritual, educational, and funerary functions within Islamic architecture (figures 4.7 and 4.8).

Different Typologies of Ablution Spaces within Religious Complexes

From our study of the ablution spaces within the historical complexes in Marrakech, we identified three distinct spatial arrangements, presented in figure 5, which highlight their functional and/or decorative roles in relation to the prayer hall and courtyard.

Decorative Fountain Role In the first diagram, the water infrastructure (shown in blue) is positioned within the courtyard (green), serving primarily as a decorative feature. The ablution space, however, is located separately from the main courtyard and prayer hall (red), ensuring that worshippers perform their ablutions in a designated external area. This configuration emphasizes the aesthetic purpose of the courtyard fountain while maintaining the practical function of ablution in a more secluded area.

Functional Ablution Fountain The second diagram presents a layout in which the courtyard fountain plays a dual role, functioning as both



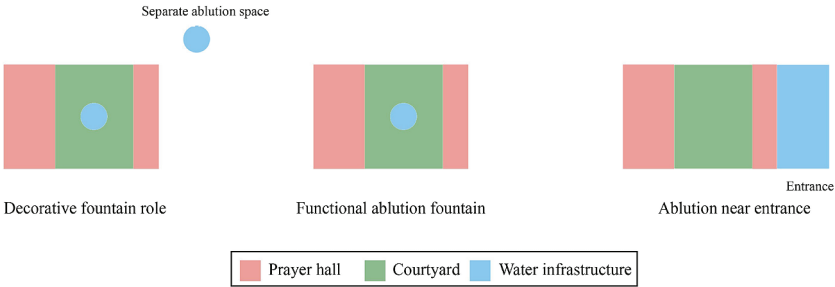


FIGURE 5 Visual Representation of the Organization of Ablution Spaces within Religious Complexes

a decorative feature and a functional ablution space. Positioned centrally within the courtyard, the water infrastructure becomes an integral part of the pre-prayer ritual, providing convenient access for worshippers. This design effectively combines aesthetic and functional elements, integrating purification practices into the main circulation of the mosque.

Ablution near the Entrance In the third diagram, the ablution space is placed near the entrance of the mosque complex rather than within the courtyard. This strategic positioning allows worshippers to perform their ablutions immediately upon arrival, ensuring a smooth transition into the prayer hall. Separating the ablution space from the courtyard emphasizes functionality and efficiency, accommodating a high flow of worshippers while reserving the courtyard for social and spiritual activities.

RESULTS

Example of Non-Destructive Analysis of the Almoravid Qubba

Among the three ablution spaces analyzed in our study, we conducted a non-destructive assessment of the Almoravid Qubba, using it as a case study to demonstrate a comprehensive structural diagnostic approach. We utilized photogrammetry to document the exterior façade of the Almoravid Qubba, while LiDAR scanning was employed to generate 2D plans and analyze the spatial configuration of the surrounding area. Image capture was carried out using a Canon EOS 1100D camera, equipped with a 30mm lens, set to an aperture of f/8, a shutter speed of 1/125 seconds, and an ISO of 100, without additional flash illumination (figure 7). LiDAR scanning was performed with an iPad Pro 3D scan-

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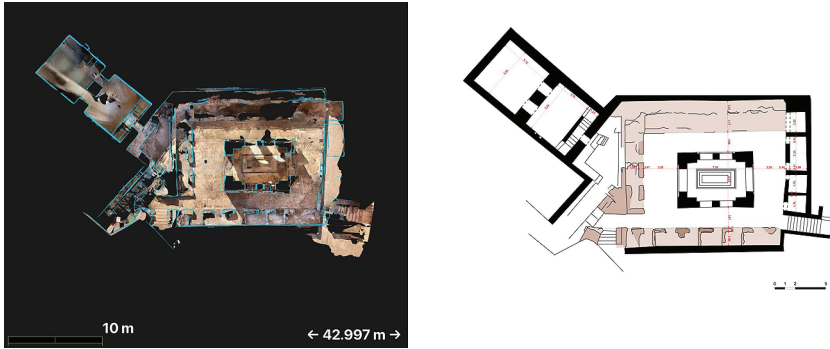


FIGURE 6 Blueprint of the Qubba generated using 3D scanner app on an Ipad Pro
NOTES Left: blueprint obtained from 3D LiDAR scanning; right: plan after post-production.

FIGURE 7

3D Volume
Generated from the
Point Cloud Model
of the Qubba Using
a Photogrammetric
Scan



ner app to obtain detailed spatial data and produce accurate 2D plans of the surrounding area (figure 6).

Using both 3D LiDAR scanning and photogrammetry, we captured the architectural features and water systems of the Almoravid Qubba with a precision of 5 mm. These technologies enabled the preservation of highly digital models that document the current condition of these structures and support future restoration efforts aligned with its historical authenticity. The scans revealed the architectural details of the Qubba's water systems, confirming historical accounts of its function as an ablution space, and offered insight into the extent and ef-



TABLE 1 Structure Diagnosis and Anomalies

Anomaly	Description	Potential causes	Conservation recommendations
Surface cracking	Extensive cracks on the floor and surrounding surfaces, indicating aging materials and structural stress.	Thermal expansion, material aging, structural stress.	Conduct a structural assessment and apply protective coatings.
Moisture stains and discoloration	Dark patches and stains suggest past water infiltration or prolonged humidity exposure, leading to potential material weakening.	Water infiltration, humidity, poor drainage.	Improve drainage and apply conservation treatments to affected areas.
Erosion and surface wear	Edges of the basin and floor show signs of erosion due to long-term water exposure and human activity, resulting in uneven surfaces.	Prolonged exposure to water, natural wear, erosion.	Monitor erosion patterns and reinforce vulnerable edges.
Structural gaps and potential instability	Visible gaps and separations between stone slabs, possibly due to shifting or settlement, which may lead to further displacement.	Structural movement, foundation settlement, inadequate support.	Stabilize shifting components and fill gaps with compatible restoration materials.
Accumulation of debris and sediment	Small holes and imperfections have collected debris over time, further affecting the structural integrity of the stonework.	Dust accumulation, sediment deposits, lack of maintenance.	Implement regular cleaning and preventive maintenance to reduce further degradation.

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fectiveness of past preservation interventions. Integrating these modern technologies into the study of historical architecture ensures that restoration work can be undertaken without compromising original design elements. By aligning contemporary restoration methods with historical integrity of the buildings, these digital tools play a crucial role in bridging the gap between historical documentation and contemporary preservation practices.

Challenges

Some parts of the structure, especially the dome, were too high to access for scanning. Drone photogrammetry would have been needed,

but using a drone presents challenges in terms of image quality and precision.

[382] Additionally, few pre-existing plans were available for comparison with the current state of the Qubba. Only the plans by Wilbaux exist, and these were based on the archaeological remains uncovered at the site.

DISCUSSION

Identification of Architectural Adaptations and Continuities

- *Spatial Integration.* Over time, ablution facilities shifted from being separate structures – such as the Almoravid Qubba – to integrated elements within religious complexes, as seen in the Medersa Ben Youssef and the Mosque of Sidi Abd el Aziz Tebbaa. This adaptation reflects changing architectural priorities, emphasizing convenience and the seamless flow between purification and worship (Bloom 2000).
- *Technological Advancements.* Water management systems advanced from reliance on khattaras to the integration of seguias and internal cisterns. These developments improved water distribution and storage, accommodating the needs of growing urban populations and the increased usage of religious complexes (El Faiz 2001).
- *Architectural Complexity.* Later structures show more intricate designs and decorative elements, consistent with the Saadian dynasty's focus on artistic expression. Domes, ornate carvings, and elaborate tilework in ablution spaces blend functionality with aesthetic refinement (Marçais 1926). However, Almoravid ornamentation remains difficult to assess due to the limited survival of Almoravid monuments, many of which have been lost or survive only as ruins.

Continuities

- *Ritual Significance.* Throughout all periods, the fundamental religious importance of ablution remains consistent. Providing designated purification spaces underscores the enduring commitment to spiritual cleanliness as a prerequisite for worship.
- *Central Water Feature.* The presence of a central fountain or water source is a consistent architectural element in ablution spaces.



This design supports communal practice and reinforces the symbolic significance of water in Islamic tradition (Grabar 1987).

- *Use of Local Materials.* The construction of ablution spaces consistently utilizes local materials such as limestone, marble, and cedar wood. This continuity reflects both practical considerations and an adherence to regional architectural traditions. [383]

CONCLUSION

The comparative analysis reveals that ablution spaces in Marrakesh's historic mosques exhibit both adaptations and continuities that reflect technological innovation, architectural evolution, and enduring religious practices. A significant transformation is evident in the spatial configuration of ablution spaces over time, particularly in contemporary mosque designs. Modern ablution spaces have shifted from open, communal spaces to more enclosed and isolated facilities located closer to the prayer hall. Unlike historical ablution spaces – which were physically and visually connected to courtyards and the open sky, fostering social interaction and collective engagement, modern ablution spaces have become increasingly confined, limiting both their visual and functional openness. As a result, their role as a communal gathering point has diminished, altering the social dynamics of worship. Historically, ablution areas were architecturally prominent, equipped with sophisticated hydraulic systems, and served as important social nodes that reinforced communal identity and shared spiritual preparation. This study highlights the need to recognize the evolving nature of ablution spaces and their broader implications for religious and social practices, emphasizing the need to balance contemporary functional demands with the preservation of their original social and cultural significance.

This research also demonstrates that combining historical research with photogrammetry and 3D scanning provides a replicable methodological framework for documenting and conserving ablution spaces. Such an approach is particularly valuable for fragile or difficult-to-access sites, enabling detailed data collection while minimizing physical intervention. Future applications could extend this methodology to other under-studied components of Islamic religious complexes, contributing to comparative databases and informing conservation policy. Beyond historical and architectural analysis, this research highlights the importance of sustainable maintenance strategies. Practical measures include: (1) regular inspection and cleaning of water channels and

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fountains to prevent clogging and biological growth (2) monitoring and controlling humidity in enclosed spaces to reduce rising damp; (3) prioritizing the use of compatible materials such as lime-based mortars and traditional plasters in repair works; and (4) encouraging collaboration among religious communities, local authorities, and conservation specialists to ensure continuous, respectful care of spaces that are still in use.

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