Hammãms of North Africa: An architectural study of sustainability concepts in a historical traditional building

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ABSTRACT: The hammam or Islamic public bath is a traditional building type and an important architectural and urban entity of the city (médina) in the Mediterranean Islamic world. Based on recent surveys carried out by the authors on the public baths of Cairo, Tunis, Tripoli (Libya) and Marrakech; as part of an AHRC funded project, this paper investigates the ingenious architecture of the hammam and explores the passive design devices used in this traditional building and their influence on the spatial indoor ambiences. A set of four environmental sustainability indicators (representing the four natural –classical- elements) is adopted as a matrix based method, in order to explore and learn the sustainability concepts used and existing in the architectural typologies and characteristics of this specific building type. It finally concludes by proposing a set of design guidelines, which would help sustain historic structures in the future. The guidelines drawn upon the sustainability concepts learnt from this historic building can also be adapted to newly built structures.

Keywords: Hammam, Architectural typology, Urban morphology, Sustainability, Passive/Active, Concepts.

INTRODUCTION

Modern buildings are very energy intensive because they rely too much on mechanical and electrical systems for heating, cooling, and lighting. Traditional, vernacular, or indigenous buildings, on the other hand, used little energy for heating, cooling, and lighting, and what energy they did use was natural and renewable. Because modern buildings use about 50% of all energy, they are a major cause of energy depletion, pollution, and global warming [1]. More efficient mechanical and electrical systems are not the primary way of reducing the energy consumption of buildings. Rather, it is the design of the building itself that will have the greatest impact on reducing the energy requirements of buildings. For example, modern buildings rarely use shading, natural ventilation and heating devices, while traditional buildings usually did. As such is the case of the hammam or the Islamic bathhouse

The *hammām* or Islamic public bath is a traditional building type and an important architectural and urban entity of the city (*médina*) in the Islamic world. It has even been considered by specialists in Islamic Architecture and Urbanism, as the second major core building of the medina after the mosque. However, during the last century, the hammām importance has decreased and their decay started, mainly in the Machreq (the Levant countries) such as Egypt and Syria. On the

other hand, in the Maghreb (Western North Africa countries) such as Morocco, Algeria and Tunisia; hammāms are still surviving and resisting decay even though they are facing a multitude of problems [2].

CONTEXT & THEORETICAL BACKGROUND

The hammāms have played an important role in providing a key facility for the population living in the North African Médinas. They did not only facilitate the accomplishment of great ablutions prior to praying (hence their location near mosques), they also used to have important socio-economic and environmental roles in each neighbourhood and were associated with a rich cultural heritage. As a building type, hammāms have originated from the smaller type of the Roman Baths called "Balnéa" [3]. The use of these buildings is very different from a city to the others: Highly frequented in Marrakesh, averagely used in Tunis and Tripoli (Maghreb countries) to almost disappearing in Cairo and other Levant countries.

Being a special building, they mainly rely on the four main natural or classical elements: water, air, fire and earth. The water is traditionally heated in the furnace, from where the steamed air is released into the hot room. The smoke and heat from the furnace travel under the floor (through a hypocaust system, apart from Egypt where it uses piping inside the walls) providing an efficient heating technique for the bathing spaces [4].

The historic public bath as a structure has to function in extremely complex environments between the hot and cold, dry and humid, dark and light, closed and open, and private and public [2]. In this paper, the authors attempt to examine the indoor environmental ambiences of the traditional hammām building, and explore the passive design devices used in these ingenious indigenous structures.

METHODOLOGY OF INVESTIGATION

This study is based on parts of the data collected during recent fieldworks carried out by the authors on the historic hammāms of Cairo, Tripoli, Tunis, and Marrakech. The data were collected via:

- On site physical and photographic surveys of the buildings
- Social and behavioural observations of the hammām users.
- Interviews/questionnaires with hammām owners and users
- · Interviews with architects dealing with restoration
- Cross-checking different data sources

For the purpose of this study, the data were analysed and synthesized using a matrix based model of indicators to enable the gauging of the passively heated, cooled/ventilated and lighted spaces inside the hammām. Therefore modelling these buildings according to their temporal and spatial location allows us to identify a set of environmental sustainability indicators based on the classical elements: air, water, fire and earth. The surveyed public baths, located in Cairo (Egypt), Tripoli (Libya), Tunis (Tunisia) and Marrakech (Morocco) have been architecturally and "urbanistically" analyzed. Furthermore, passive methods of heating, cooling and lighting have been examined. Performances of these passive devices are studied and assessed through the architectural and urban analyzes of both indoor and outdoor spaces of the hammām. A matrix of "sustainability" indicators specific to the hammam buildings can be applied to predict the consequences and impact of alternative options for the renovation, restoration, reuse or adaptation of these specific structures. Exploring the architectural typology and the urban morphology of the hammāms through spatial, structural and organizational analyses, provide us with the opportunity for an objective assessment of the actual performance of these buildings and the evaluation of their strengths and weaknesses towards sustainability. The paper aims to highlight the valuable lessons of sustainable architecture that this building type provides, the challenges it faces today and the opportunities it

presents for the development of contemporary sustainable public baths in the 21st Century.

ANALYTICAL STUDY

Urban Morphology / Architectural Typology At the urban scale, hammāms occupy irregular plots of land and are well embedded into the traditional urban fabric. Their position is never prominent, their entrance is discreet and their facades are totally blind. Their presence in the urban fabric is more evident at roof level because of their pierced domes and vaults that are specific to them and are not found in any other building type [5]. They are part of an urban complex (Fig. 1) composed of several urban amenities such as the mosque, the madrassa (school) and the sūq (market). Two main reasons dictated their location in the urban fabric of the medina; their proximity to the urban water distribution system (Fig. 2) and their accessibility from different quarters of the city [2].



Figure 1: The hammām part of an urban complex



Figure 2: Location of hammāms in the urban fabric; case of the medina of Tunis

The architecture took on an air of calm and solitude with the warm, quiet atmosphere of the steam bath. The hammām is smaller than its Roman-Byzantine predecessors, and more individually focused. Ceilings were low and lighting was dim. The staged, stepwise formation of spaces in the Roman bath developed into a smooth time-space arrangement. This led to an advanced spatial sequencing and to an "Architecture of Liminality" in the Islamic public baths. In architecture, "liminality" is explored as distinct threshold zones that highlight, monumentalize, and herald transition and transformation in physical, sensory, and emotional manners [6]. They present a rich variety of spaces following a sequential spatial organization [7] from cold to warm to hot rooms, passing by intermediate thermal zones (Fig. 3). They also illustrate ingenious vernacular construction techniques of domes and vaults using local building materials with high thermal mass and renders and plasters that respond to varying levels of heat and humidity.



Figure 3: Diagram of spaces, sequences and internal ambiences inside hammām Darghūt in Tripoli (Libya).

Spatial composition, organisation and sequences The spatial organisation adopts almost a similar gradual transition from the cold to the hot spaces. However there is a stricter geometrical organisation of the spaces. The building is composed successively by the $Sk\bar{t}fa$ (entrance vestibule) where a barber works, and then the changing room called *Mahras*.

In al Kashāshīn, the *mahras* is almost a perfect square of 8.8mx 8.60m, which is covered by a nicely decorated dome mounted on doubled vaults covering the peripheral annex rooms (*Maksoūra*). The hemispheric shaped dome is supported by four impressive columns. Next room is called *Bayt Lawal* (cold room), a transition room to *al Wastani* (medium or warm room). It is a large room, of rectangular shape (8.20m x 5.60m), covered by a central dome and peripheral vaults. In the middle of room there is a large rectangular stone-bench, where the bathers are massaged by the $Kiy\bar{a}ss$.



Figure 4: Plan of hammām al-Kashāshīn, Tunis

Bayt Skhouna (hot room) concludes the internal rooms of the *hammām*. It is a smaller room in the shape of a lengthy rectangle (8.80 x 4.10) covered by single vaults. Half buried in the ground, it conserves well the heat. In the middle of the room and by the wall, there is the *Nahāssa*, or the copper tank of hot water. Behind the wall is the *Furnāq* (Furnace). The *hammāms* of Tunis use the hypocaust heating system.

The Natural Elements & Sustainability Indicators

Air The undressing/dressing room is usually accessed from the street through a bent entrance which prevents visual intrusion into the internal spaces. This room is usually covered with a high dome and is the largest and most decorated space in the hammāms of the Maghreb. In Cairo it is usually covered by a wooden roof covered with a square opening called "Choukhchīkha" (Fig. 5).



Figure 5: The wooden ceiling of the changing room in a Cairene hammām.

This large space allows cool air to enter the hammām and facilitates the natural ventilation of the first passive zone of the structure.

The most distinctive feature of the hammāms is the way the domes over the washing rooms are pierced with circular or star-shaped roof lights, forming intricate patterns. Whereas Roman and Byzantine bathhouses are naturally lit with a central lantern at the top of the dome and windows placed at the lower edge of the dome, the Islamic bath houses are characterised by multiple circular or star-shaped openings over the whole surface of the dome and closed by glass caps. These openings consist of pottery tubes built into the domes, closed by glass covers and arranged according to various decorative patterns. Some of these glass bulbs are removable in order to allow for natural ventilation to take place when the bathing spaces are not used [5]. They allow for daylight to enter the bathing spaces and create a special atmosphere enhanced by the high concentration of steam in the bathing spaces. The steam helps the diffusions of day lighting inside the bathing spaces with reflective and diffusing effects (Fig. 6).

height. The warm and hot rooms are heated using the hypocaust system traditionally used in the Roman baths. The hot smoke from the fire travels under the floor of the hot and warm rooms before rising up a chimney in the walls (Fig.7). Once the air has passed under the floor, it is drawn into the walls and up the flues due to the hot air already rising in the flues creating a partial vacuum. The heating system is a labour intensive device as it requires constant attention to feed the fire and remove the ashes. The "Furnacci", the heating system attendant works from four o'clock in the morning until 10 o'clock at night, keeping the furnace fire going by throwing fuel into the furnace on a regular basis (Fig. 8). The heating was operated by burning by-products of local traditional workshops, especially olive presses and wood workshops. It used to act as neighbourhood recycling centre for local by-products such as wood chippings, olive stones and combustible rubbish and even sometimes act as a neighbourhood oven it is used as an oven for the neighbourhood.



Figure 6: Daylighting devices inside bathing spaces in a hammām in Tunis; passive design device.

One of the consequences of the burying/half burying of the hot room spaces in the hammām is the pit effect. It allows concentrating the cool air at the bottom of the lobby and keeps warmer air in the upper layers by a thermo-dynamic movement [8].

Fire The heart of the hammām is the furnace. It is built against the longitudinal wall of the hot room. It has its own entrance for the delivery of the fuel and only communicates with the bathing spaces via the under floor heat tunnels. The furnace is also used for other socioeconomic functions. In Egypt it is used to cook favabeans, while in Marrakech it is used to cook "Tangiya" a special local recipe. The fire is lit under one, two or four large brass copper cauldrons measuring one to two meters in diameter and three to four meters in





Figure 8: Furnacci working in the hammām furnace in Marrakesh.

Water Water is one of the main elements keeping alive the hammām. Sustaining its use is important. The

majority of bathhouses were equipped with their own bi'r (well), however they still needed to have additional quantities of water to fill their cisterns and tanks, especially during the hot summer periods when water consumption increased. Hence their location next to main transportation routes but also to the water distribution system.

The use of water inside the hammām is regulated on the basis of the quantities of water heated by the furnace. Basins and pipes are designed in a way to reduce water consumption accordingly to the number of clients, but also to the human body needs for washing and cleaning.



Figure 9: Section in hammām Bab al Bahr, Cairo (Bouillot, 2006) [9].

Earth One of the main requirements of the building envelope is to have a high level of thermal mass in order to keep the heat in. Another reason is to support the roofing structures and ground pressures when buried, and give a strong inertia to the building [8]. The walls are traditionally built of a base of thick stone topped by brick construction and the domes and vaults are built with bricks. The floors are tiled with stone or marble or with ceramic tiles as is the case in Morocco. Special waterproof renders and plasters are made from a lime mortar to which ashes from the furnace are added. Brick and brick buildings are sustainable because they:

- Are highly durable
- Offer long term life performance
- Are low maintenance
- Are energy efficient
- · Provide healthy and comfortable environments
- Are recyclable [9]

If you spread the CO2 emissions from the brick in a square metre of brickwork over a life of 120 years it equates to 0.000232 tonnes of CO2 /sq metre/per annum. This carbon isn't "locked up" to be released at the end of life, it has already been expended and the longer the building exists, the better the value. Very little clay is wasted during manufacture. Unfired waste clay is reused in the manufacturing process and less than perfect fired bricks are crushed and used as aggregates in other parts of the building industry [10].



Figure 10: Dome pierced by lighting devices, hammām in Marrakech.

Another characteristic related to element "Earth" is the burying/half-burying of the hot room. This allows an important increase in the inertia of the building and its capacity to store energy, and expands the embodied energy of the wall materials (bricks).

SUSTAINABILITY CONCEPTS IN HAMMAMS

It is clear that the hammām as a traditional building type offers a number of sustainability concepts and principles in terms of construction, heating system, water use, natural ventilation and day lighting. Although there are clear regional variations, and which we could not target in this short study, there are common opportunities that can be developed based on the four classic elements around which the architectural analysis developed, such as water storage and management and the use of solar energy at the scale of a neighbourhood. The hammam as a building type could be reinterpreted for the development of a new urban facility that can be easily built in tight urban infill plots, making good use of derelict urban sites. There is however a need for developing new guidelines for both the restoration of historic hammām structures and the construction of new ones. Those guidelines should not only be based on the various lessons the historic hammāms present in terms of architecture, construction technique, space, water, ventilation, lighting and heating systems but also on the new health and safety regulations and new building technologies that can be appropriately applied in this building type. In one hand we can list the two main environmental characteristics of a Green hammam:

- Strives to conserve energy and water resources.
- Is committed to using materials that can be recycled, follows recycling practices, and is always looking for ways to minimize waste.

In the other hand, hybrid alternatives could offer the solution to adapt the passive smart design of traditional building to contemporary technological development. Furthermore, as the hammām plays a role on the environmental sustainability, it is also a cornerstone for socio-cultural-economic sustainability.

The public bath plays an important role in the social activities of the Muslim community. It is the venue for a number washing rituals and the conduct of major ablutions before prayers. It is also a meeting space for interaction of various social groups, which regularly visit the hammām. The public bath strengthens the bonds between its regular users in specific and the local community in general.

CONCLUSION & RECOMMENDATIONS

The main role of the hammām in the Islamic has been to provide a venue for health and cleanness for people, but also a space for gathering and socializing. In the modern era where bathrooms are common, the personal hygiene function of the hammām may no longer be a priority, but the institution itself remains a highly attractive healthoriented social place, both for tourists and locals.

In summary, a hammam facility designed to cater for the 21st society has to include all these considerations. It seems desirable to provide venues and spaces which will be attractive to different social classes for weekends and holidays thereby strengthening social cohesion. As a result of this, newly designed hammam facilities will inevitably derive from the traditional ones. However contemporary developed functions must be added. This extra functionality will find expression in the architectural solutions chosen to accommodate the additional activities to the core function of the hammām. Hence, the newly developed bathhouse complexes will be designed using local materials (i.e. bricks and stones) for the structure and, incorporate the distinctive domes and vaults, as seen in traditional historical practice. These architectural elements must be kept in new hammāms design as they play an important role in translating the ambiances and spatial comfort inside the structure.

In order to accommodate other activities to take place within the hammām complex, the use of contemporary building materials such as steel, glass or plywood is important, emphasizing the lightness of structure and versatility. The choice of materials responds to the architectural expression of the old hammām tradition rooted deeply in history and yet modified to incorporate new contemporary requirements such as convertible spaces and hybrid heating system (i.e. usage of preheating solar panels).

Designing a hammām needs a method which consists of a rich combination of human intuition, life experience and nature analysis. This paper investigates this process and suggests that there might be useful lessons of sustainability for today's architecture and urbanism which should be learned from yesterday's experiences to sustain our future. Finally a set of design guidelines has been designed for the adaptive reuse of historic buildings in general and for the hammāms in specific. These guidelines can also be adapted to newly built structures. Thus, this would constitute the perspectives of further research accordingly;

- Practical energy assessment of the structure
- Development of an integrated approach
- Energy usage and environmental factors impact
- Combination of energy measures: Hypocaust technology, heating controls, thermal insulation, solar panels used to pre-heat water in the furnace
- Use resources from sustainable sources (i.e. wood, recycle water...)
- Develop new technologies: Hybrid (i.e. a modified furnace tank)

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Note, The International Journal of Middle Eastern Studies IJMES transliteration system has been used in this paper

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