

Collective ingenuity in the construction of the popular home: The challenge of the know-how in Sahara

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Received: April 2018 • Final Acceptance: January 2019

Abstract

As everywhere in the world, every traditional masterpiece emanates from a system in which the natural and cultural environment intersect, and are superimposed on a set of local know-how. It is these ancestral techniques and practices transmitted from generation to generation which, Achieving harmony between habitat and the environment, even a symbiosis between techniques, us, customs, and socio-cultural values, allow building architectures and landscapes with obvious universal value.

However, traditional know-how including innovative solutions appropriate to each environment, are at risk of lapse or total disappearance leading to the disappearance of an entire culture.

Typically, the popular house in Bechar (city located at the gates of the Algerian Sahara), this collective production has proved its worth for centuries, in a severe environment with arid climate. The objective of this work is to show the ingenuity of this construction deflecting the cold, the wind and the sun with passive means able to face undeniable challenges in the face of current production with artificial means (without any adaptation to climate and local context).

Keywords

Popular home, Know-how, Sahara, Ingenious construction, Climate.



1. Introduction

In ancient times, the architecture of “inhabiting” allowed “living together” and let the «temples and tombs» the task of hosting the “die-alone.”. Today, the situation seems reversed; the sustainable housing is rather based on the facts of the environment than those of social. Sustainable architecture is therefore in matter and in the social fact as well. It also organizes our relationships in the environment inside according to the dual axis to take advantage of the environment (benefit, protection, enjoyment). To extend the service life of a building and reduce environmental impacts, its design must anticipate changes in the current and the future user needs.

But, many countries in hot climates remain devoid to this evolution, and the problems related to the degradation of the environment are of increasing concern. In terms of architecture and urbanism, designers must have answers to the problematic of the uncontrollable inhabiting, more related to climate damage.

Throughout human history, man has had to satisfy such important needs as protection, shelter and preservation in order to survive in both natural and artificial environments (Arcan et al, 1999; Guliz Ozorhon et al, 2014). To achieve this, people organized the areas they chose within the natural environment and used bordering and encircling applications to modify these areas into new and safe artificial spaces (İzgi et al, 2003; Guliz Ozorhon et al, 2014)

2. Vernacular architecture

Before being an economical, ecological construction, vernacular architecture is a response to social needs (Asquith et al, 2006; Farajallah et al 2017) . Renowned for its simplistic techniques and materials shaped by local culture, it tries to adapt to the climate and geographical situation (Aziz and Shawket, 2011; Toe et al, 2015; Farajallah et al 2017). Among these materials, we mention adobe (clay or mud) used all over the world for thousands of years (Farajallah et al 2017; Bodach et al, 2014; Priya et al, 2012; Yorulmaz, 1981; Saljoughinejad et al, 2015).



Figure 1. Photos show the results of transformations: the search for an artificial internal comfort: the air conditioning and heating. Source: Authors.

For example, adobe is used in some modern buildings in different countries where climatic conditions are different. (Farajallah et al 2017; Loaiza et al, 2002; Hall et al, 2012; Kumar, 2002). Just as a multiplicity of passive vernacular techniques (interior courtyards, wind towers, sensors,...) are similarly applied in modern buildings (Farajallah et al 2017; Hyde, 2008). However, there are some vernacular techniques that have been developed for the hot climates of the Sahara to benefit from cooling and natural lighting. These are courtyards, wind towers, domes, air vents, planting, water walls, solar chimneys, and mushrabiyah (Farajallah et al 2017; Alp, 1991).

2.1. Vernacular architecture in arab world

From desert Bedouinism to modern urban planning, from tents to housing, vernacular architecture is changing, affecting its techniques and performance. (Farajallah et al 2017; Alp, 1991). The vernacular dwellings were built using locally produced materials, such as clay (adobe), limestone, stone and wood. Adobe made of clay, sand, silt and water, and used in the construction of walls, roofs has proven its worth in hot desert regions, and has stood the test of time (Farajallah et al 2017; Algifri et al, 1992) . Saleh showed that houses in Saudi Arabia (example of saharian geography) made of adobe have a better energy performance than buildings built of stone (Farajallah et al 2017; Saleh, 1990). Generally, the thickness of adobe walls is about 30 to 50 cm, whereas it should be at least 45 cm thick to obtain the total thermal mass, and typically, the roof is 30 to 40 cm thick (Farajallah et al 2017) Despite its supreme thermal properties, concrete

and steel have nevertheless blurred the adobe (Farajallah et al 2017; Austin, 1984; Revuelta et al, 2010; Saleh, 1990; Heathcote, 2011).

Researches show that, in traditional Arabian Muslim houses in some region, according to wind speed measurements (Figure 12),utilizing prevalent wind-flow in natural ventilation can provide a comfortable environment, a statement that is certified by the lack of electrical devices in the studied houses across the region(Sadra et al,2017).

2.2. Traditional shading elements: (iwan) evons, eyvans (porchs) and talar; the opening

Eyvan and Talar are semi-open spaces (open on one side to the central courtyard) (Sadra et al, 2017;Pirnia, 2010; Foruzanmehr ,2015) they are combined with other techniques such as domes and wind sensors, water and vegetation use, contribute to the environment (Sadra et al, 2017;Mashhadi, 2012), (Figure 3), provides indoor spaces with favorable thermal comfort. (Farajallah et al 2017; Saljoughinejad, S et al. 2015).

Iwan is a traditional element that provides shade for buildings, reducing incident solar radiation (Platzer, 2001, Hamid et al, 2018).

Several shading system have been used in buildings to reduce energy consumption, especially in hot climates (Hamid et al, 2018; Mateus and Oliveira,2009. Baniyounes and all, 2012). and improve the energy performance of buildings, such as external and interior blinds (Hamid et al, 2018;Florides et al, 2000), overhangs (Hamid et al, 2018;Lee and Tavit, 2007), Venetian blinds (Hamid et al, 2018;Hans and Binder, 2008) and canopies (Hamid et



Figure 2. Photo of a patio in Ghardaia. Source: <https://quintessences.u.q.f.unblog.fr/2014>

al, 2018;Kenneth et al, 2010).

While buildings require huge amounts of energy for cooling and heating, the cost of energy types is increasing (Hamid et al, 2018;Liddament, 2000. Kirmat et al, 2016).The amount of energy required for comfort inside buildings depends on the climate inherent in this region (Hamid et al,2018;Anand et al, 2013;Susorova et al, 2013).

Among the energy saving strategies in buildings, passive solar energy seems to be proving its worth (Hamid et al, 2018; Ralegaonkar and Gupta, 2010). Traditional Muslim architecture has always adhered to this solution (Hamid et al, 2018;Khalili and Amindeldar,2014). using wind sensors (Hamid et al, 2018;Saadatian et al, 2012),Shovadans (Hamid et al, 2018;Moradi and Eskandari,2012), yards (Hamid et al, 2018;Safarzadeh and Bahadori, 2005) and domed roofs (Hamid et al, 2018;Faghih and Bahadori,2011) as well as the tanks (Hamid et al, 2018;Ameri et al,2011) ice wells (Bahadori,1985); for cooling arid regions (Hamid et al, 2018;Bahadori,1978;Khoroshiltseva and all,2016; Datta,2001). Mehrotra has developed the thermal performance for the windows of a building with a shading model (Hamid et al, 2018; Mehrotra, 2005).

(Hamid et al, 2018; Tzempelikos et al, 2010), found that insulating glass facades with low transmission coefficient create comfortable and stable conditions. The shading system made it possible to experimentally study the indoor thermal environment near a glass facade under variable climatic conditions in winter (Hamid et al, 2018;

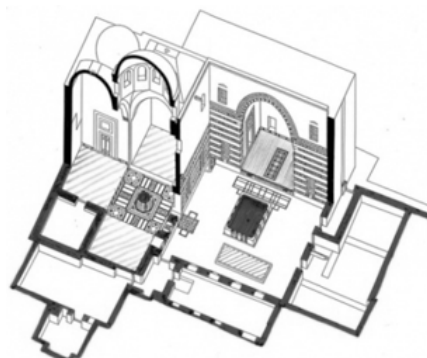


Figure 3. Photo of a IWAN. Source: David J. David.

Bessoudo et al., 2010). The shading system prevents solar radiation from entering the building in summer, while allowing solar radiation to increase in winter (Hamid et al., 2018; Haeri, 2010). Iwan as a passive shading system widely used in Middle East and North African architecture (Hamid et al., 2018; Florides et al., 2002).

2.2.1. Courtyards or patio

The inner courtyards of houses in the Arab Maghreb are generally small but deep, and less exposed to the winds (Figure 5). Their main role is to promote lighting and ventilation in dense urban areas (Carlos et al., 2015). In summer, they provide indoor freshness, as their characteristics they cool the air at night by wavelength radiation and ventilation (Carlos et al., 2015; De Lama et al., 1991). During the day, they are covered with solar rays by canopies, cooling the surrounding rooms with air stored at night. Sometimes streams are equipped with water and vegetation that create a pleasant indoor microclimate (cooling is provided by evaporation). In winter, the courtyards provide heat gains, which are diffused into the surrounding rooms (Carlos et al., 2015; Safarzadeh and Bahador, 2005). Contrary to traditional houses rely on courtyards for energy savings, modern buildings consume 30 to 40% of the world's total energy consumption, with a potential to reach 50% by 2050 (Sadra et al., 2017; Marin and al., 2016).

2.2.2. Facade

External facades are usually blocked by attached neighboring houses in order to reduce the area of external surfaces that face direct sunlight and hot winds. Openings are few, the only opening to the outside (Figure 4) is the houses' entrance door (Sadra et al., 2017; Khajehzadeh et al., 2016).

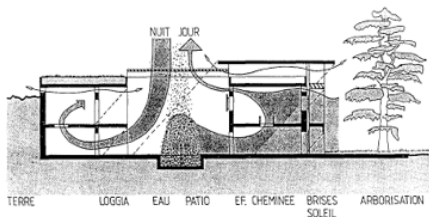


Figure 4. Schema 1, 2 of climatique functioning of a 'patio'.
Source: <https://quintessences.u.q.f.umblog.fr/2014>

3. Presentation of case study



Figure 5. The spatial composition of ksar: the statement.
Source: Authors.

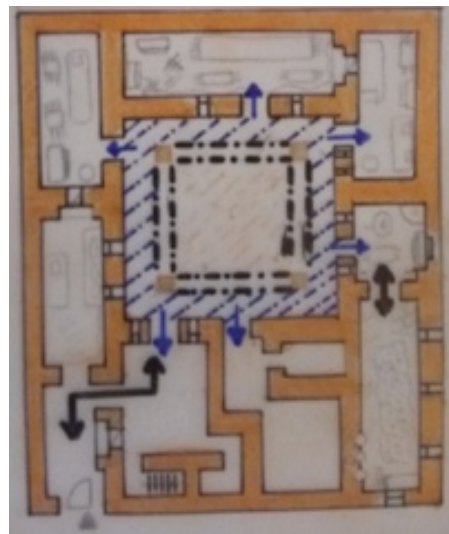


Figure 6. Plan of a typical popular house.
Source: Authors.

4. Urbanism in the Sahara

"The Sahara is a hot country where there is intense cold" (eim. E, 1966). The people of this hostile environment acted to the extreme of their knowledge and their know-how, on a semi-desert site, with fairly limited resources, to undertake institutions that meet both their pressing needs and their difficult living environment. At the urban level, two parameters are essential in the choices of implantation in hot, dry climates:

The first is the presence of water and vegetation, being natural cooling fac-

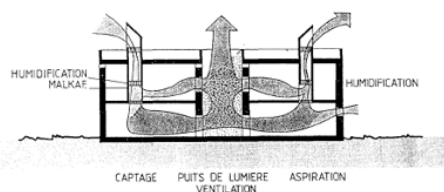




Figure 7. Representative photo of the urban morphology of vernacular fabric, wilaya of bechar.



Figure 8. House of an extended family in a traditional fabric. Source Fouzia M, K. T. Aoul, (2001), redrawn by the author. 1-entrance, 2-vestibule, 3-bedroom, 4-cuisine, 5-the middle of the house, 6-guest room, 7-storage room, 8-wc.



Figure 9. Arrangement of traditional houses in kenadsa. Source: Khizana Kenadsa.



Figure 10. Cylindrical jars buried to preserve dates (khubaya) in "el ksar" of the house "Béchar's ksar" source House of culture wilaya of Béchar, photo by M.A.Djeradi, 2013.

tors, humidifying the air and shading the soil. It absorbs less heat than the building materials. The evapotranspiration increases the relative humidity of the air and regulates the temperature.

The second is the importance of the slope and its orientation, which determine the potential rate of ventilation of the site. Urban density is also favorable in hot climates because it limits the surfaces exposed to radiation.

4.1. The social role of the courtyard

The compact urban fabric have a sociocultural interpretation which is considered determinant factor more than climatic factor, the insertion of the house in its neighborhood is essential in the traditional city: the neighborhood is an extension of the house. The neighborhoods are urban units that have their identities, traded from several streets and dead ends. Each neighborhood has its own basic amenities. The ksar is divided into several districts whose boundaries intersect in the central square where the great mosque is located. The concept of the courtyard was employed in saharian houses to seek privacy, natural ventilation and day lighting, The desire to preserve and protect woman by establishing limits that are impossible for any stranger to the family is the mark of his appropriation of the domestic space this is reflected in the separation of the feminine domain from which women practice space freely and the male domain. Cohabitation between several family cells forms of solidarity referring to a traditional social organization.

4.2. Techniques of popular architecture in the desert climate

This climate is characterized by two seasons: a long hot season, when there is no rain, and a cold season of shorter duration, during which the rain showers are occasional. Throughout the year, the prevailing wind blows from the south, southeast. The comfort of the inhabitants does not require special air circulation, given the dry character of the climate. Thus, protection against sunshine prime on ventilation. It is suitable for all seasons to have homes



Figure 11. Photo shows the compactness, an example of a lane in a Vernacular popular fabric overlapping floors for shade in the streets and protecting facades of solar rays. Source: <https://www.google.fr/search?q=ksar+de+béchar>

Figure 12. Photo shows the facade declined small drilled outside. Source: <https://www.google.fr/search?q=ksar+de+béchar>

Figure 13. A type of support very answered in the architecture of Ksour In the form of post called “elsouaries”. Source: Authors.

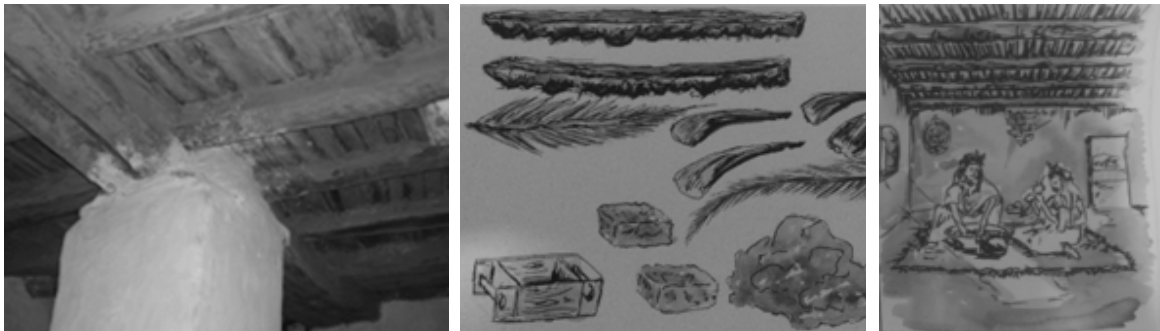


Figure 14. Type of traditional stake: in palm trucks supported by beams of the same material. Source: Authors.

Figure 15-16. Building materials. Source: Authors.

in compact groups around courtyards and spread them in many narrow streets. (See figure 3 and 9).

4.2.1. Constructive building materials and systems

The walls: boundary between the inside and the outside. The constitutive materials, thickness, color, coating and thermo physical property are the main factors in their ability to modify the thermal exchanges. In arid regions, it is necessary to achieve high thermal inertia walls having the capacity to store heat during the day and return at night to reduce the temperature fluctuations that are the basis of the discomfort.

4.2.2. Massive Construction

The massive construction provides shading spaces and facades.

4.2.3. The protection of exterior walls

Protection of external walls has the objective of shutting down, to slow down and reflect solar flux. Several devices can be implemented:

- The decline of the facade and roof overhangs
- Wood and palm awnings protect vertical walls and procreate shading entry
- Reflective materials; clay mortar in the same color
- Local natural materials act as insulators
- The foundation of the pillars and structural walls in natural stone

Figure 16: Example of an old arch built according to the constructive tradition of the region: An arcade of the

Ksar of KENADZA; Despite the deterioration of the roof and the degradation of the plaster and some stones constituting the arch, the work still resists due to the good disposition of the stones arch built without formwork by flat stones to note the way in which the arc is closed (source the culture house wilaya of Bechar)

Figure 15, 17: cracks and degradations of earthen arches: The absence of the protection of the roof caused cracks, excavations and erosion of the earth material at the level of the bearing structure of the house in particular at the level of the arcades (source authors)

4.3. Internal distribution of spaces in the popular houses



Figure 17. Cracks and degradations of earthen arches: The absence of the protection of the roof caused cracks, excavations and erosion of the earth material at the level of the bearing structure of the house in particular at the level of the arcades. Source: Authors.



Figure 18. Example of an old arch built according to the constructive tradition of the region: An arcade of the Ksar of KENADZA; Despite the deterioration of the roof and the degradation of the plaster and some stones constituting the arch, the work still resists due to the good disposition of the stones arch built without formwork by flat stones to note the way in which the arc is closed. Source: The culture house wilaya of Bechar.



Figure 19. Cracks and degradations of earthen arches: The absence of the protection of the roof caused cracks, excavations and erosion of the earth material at the level of the bearing structure of the house in particular at the level of the arcades. Source: Authors.

4.4. Ingenuity in construction's technique

The inhabitants use local building materials and resources. Bearing walls at a thickness of 50 to 60cm are erected with a large number of earth bricks made on site. - A sandy soil is used (50 to 70%) and clay (20%). Slightly moistened, land is put into molds and lightly compacted by hand. Once unmolded, it dries in the sun and gives birth to mud brick. Once dry, the bricks are mounted as cinder blocks with mortar made with the same land as bricks but screened to avoid the gravel. A coating of the same material with a thickness of about 2cm just covers the walls. This type of wall slowed the transfer of heat inside spac-

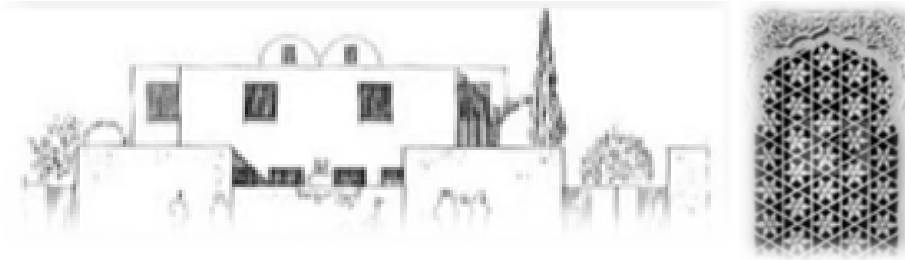


Figure 20. Graphic appears a popular home with a court contain plant and patio covered with a dome containing from the top small windows for ventilation. Source: <https://www.google.fr/search?q=ksar+de+béchar>

Figure 21. Photo shows the shape of “moushrabiah” sun protection. Source: Author.

es. The Inner surface temperature of the wall facing the sun begins to take uncomfortable temperature values at dusk. The flat roofs of a significant thickness 30 to 50cm are made from palm trunks of 3.00 to 3.50m of reach, put on bearing walls which support log, spaced at regular intervals of 50 70cm, tree branches are then placed perpendicular on the logs and support one or two layers of palms used to absorb water and serve as a formwork to put clay mortar above. However we can get a room climate or microclimate bearable during the hot period by carefully selecting the materials and design details. Unfortunately, the materials used in the actual construction such as concrete, cinder block and glass, are characterized by poor thermo physical against the intense sunlight that characterizes the region. The Wall today has become a mere boundary between outside and inside. The roofs have a low thermal inertia; do not have significant insulating properties constitute an absorption surface to solar radiation. (Liébard and De Herde, 2005).

5. The transformation of the know-how

5.1. Related to climate

Like all cities of the sahara, Béchar experiencing excessive and uncontrolled development, the consequences have resulted architecturally by:

The loss of identity and its bioclimatic qualities: efficient materials and appropriate techniques to integrate climate and environment.

The applications of the vernacular construction techniques and materials have been demonstrated as a sustain-



Figure 22. Graphic shows the shape of a patio interior. Source: <https://www.google.fr/search?q=ksar+de+béchar>

able option for buildings (Farajallah, 2017; Heal et al, 2006; Sayigh, 2014). However, these techniques and materials are not being employed anymore in the Arabian building industry (Farajallah, 2017). On the other hand, the modern houses have thinner walls and roofs and are made mostly from hollow blocks and reinforced concrete (see Figure 1).

Indeed, the presence of an urban group profoundly modifies the structure of the lower layers of the atmosphere as the dynamic point of view or thermal one. The air flow is very disturbed by the numerous obstacles and of unequal heights that characterize urban areas. In addition, replacing the natural soil by large expanses of concrete, asphalt, stone, etc., and the concentration on a small space of combustion processes (heating, industry, transport) cause a significant change in the energy balance between soil and atmosphere. The air pollution that changes the composition of the atmosphere of the cities also causes a modification in radiative exchange and

precipitation. Finally, the impermeability of the ground and lower evaporation transpiring surfaces disturb the water balance. (Sacré 1983). Contemporary home seems to break with the traditional popular building because extroverted composition of the inhabited space, the use of new materials (concrete block, cement, concrete, industrial brick) has become widespread, and gives an appearance similar to that of existing buildings throughout the country, despite the difference of climate context. The use of air conditioners producers of greenhouse gases, which increases pollution, lowers the environmental and climatic conditions. Because of the importance of conductivity and thermal diffusivity in the development of thermal balance (the thermo physical properties of new materials: thermal conductivity “ λ ” and thermal diffusivity “ a ”) The production of state housing is an important part of the total output of the city. It’s a massive production of open fabrics, consisting of bars without concern urbanity “with wide streets, exposed to violence sandstorms and heat of the sun. They are built in a repetitive alignment block of 4 and 5 floors, without relief or soul, cold in winter and hot in summer. This shows the inability of contemporary urbanism to adapt to the specificity of the Saharian environment.”

Therefore, if the environment is predominantly urban, an increase of the ascending heat radiation with big wavelength emitted by the environment.

5.2. The form is a social interpretation of a local culture

5.2.1. The social logic of spatial distribution and design

The qâ’a expresses, (see figure 3) by a step and marking in the wall, a purely spatial distinction, but makes visible a symbolic hierarchy: the “low” part, durqâ’a, is a distributor element, subordinate, it serves the circulation and the service, while the master (or mistress) of the place stands with his guests in the “high” part, noble, Iwan, where the places farthest from the threshold are the most honorable hierarchy noble space and daily space.

5.2.2. The popular home in arab-muslim world is a projection of a cultural image

Culture has always been an essential dimension in the life of man who has manifested in the production of his living (Platzer, 2001). The ksar as a vernacular territory does not only express the environmental and landscape values, but it is also, the reflection of the local ethos (Hamid et al, 2018). Explain the choice of site and morphology of human settlements only by ecosystem constraints and / or technology is in our opinion, insufficient. Given the spiritual (sacred) seems at least as important, if not the most crucial (Hamid et al, 2018). Indeed, this architecture that is specific to a community characterized by its own representations is regarded as a reduced model of an Arab-Muslim city (Hamid et al, 2018). This is due to the organizational characteristics which it presents from the formal and functional point of view. On the contrary, other experts consider that these ancestral cities existed well before the arrival of Islam; they were confronted with several socio cultural and environmental factors, which engendered their morphology and their specific organization (Figure 7, 8, 9). In the Arab-Muslim, the religion has often been served as a landmark in the design of the dwelling and the urban landscape. As an example, we cite the choice of the orientation (even if this choice is irrational compared to other criteria), the requirement of a distinction between the sacred and profane spaces. The issue of intimacy and the degree of openness to the outside are also determinant, by consecrating the inviolability of the private life (very rigorous ranking of spaces, by distinguishing the passage of places from the most public to the private ones, chicane entrance, introverted house, moucharabieh windows...). At the neighborhood level, it has led to sober uniform facades, allowing no distinction between the housing of the rich and one of the poor, despite the large difference of the interior. What strikes the observer, here is the general character unit.

5.2.3. The expression of the material world in the Arab Muslim culture

The landscape is considered as the cultural expression of the perception of the material world and its representation (Liddament, 2000). As the landscape can have diversified significances, since numerous cultural elements which are closely linked to a context, can intervene in the decryption of these deferent significations (Kirimtat et al, 2016). The decoding of the landscape presumes a common language (Liddament, 2000). Thereby the study of the logic of the landscape construction requires the knowledge of the cultural specificities and conventions that are particular to the society concerned with the analysis. The example of the palm plantation (el-Jenna) in the construction and the conceptualization of the landscape oasis are particularly edifying. The palm tree as a sacred tree of Islam and symbol of eternity is regarded as a crucial factor of the structure of the oasis landscape. In addition to the fact that the palm plantation is a work place, it is also a living being linked emotionally to the family. Thus, in several cases, each member of the family member owns a palm tree that holds his name.

5.3. Sociocultural factors: The transformations' origin

For a long time the work of the inhabitants, the design of contemporary houses by specialists has become the result of sedimentation of traces of exogenous and endogenous factors of transformation. No desire to have an originality of the traditional house that adapts to the physical and socio-cultural environment. The advertising discourse is analyzed as a set of cultural constructs, which, being market sensitive, reflect changing social structures, values and ideologies. Over this period the house structure has been transformed (Anand et al, 2013).

Hence, the interpretation and appropriation of the modern society values, which blur all previous simple principles, economic, ecological, based on cohabitation, social cohesion, and respect for the environment (Susorova et al, 2013).

Below is an illustration of the pro-

cess of the transformations through which the popular house passed, a typological variation accompanied by an evolution of the uses the fragmentation of the houses induces with the change dimensions of the yard.

The transformation of the habitation is linked to the metamorphosis of the built object itself: to the successive modifications of the household, considered here as a unit of members linked by relations of solidarity and cohabitation and shared interests of production and consumption.

The observations and the interpretation of the results of the questionnaire developed with the citizens show that the houses related to the town of Bechar passed during the second half of the twentieth century a multi-generational habitat, sheltering several generations and several parental families around resources, services and facilities pooled (sanitary, fire, but also products from oasis farms) and frequent use of collective services and / or public (sagia, fogara, washing, bath public ...), to a single-family dwelling. It would probably be wrong to say, however, that all these aspects of the house were determined by a single physic-architectural variable, socio-cultural factors affect (influence totaling 66%) the form (See figure 23). the plan, the facade, the technique, the volume, the appropriation of the space, the relation with the outside, and the accessibility to the site. Indeed, the different forms of housing, which the man conceived, refer to various factors (and often associated), having deter-

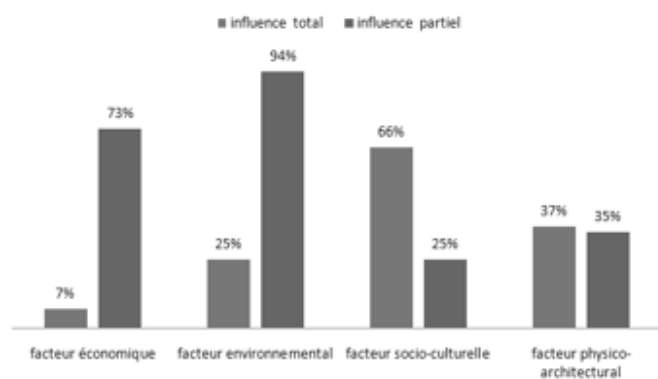


Figure 23. Histogram represents the degree of influence of the factors: socio-cultural, physical-architectural, environmental, economic on the popular house inherent to the ksar of Bechar. Source: Authors.






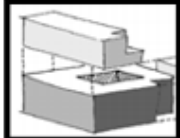
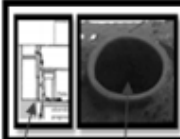



The popular home of ksar Bechar architecture's element & technique			
		Caractéristique	Cause
Tissue & orientation		<ul style="list-style-type: none"> -Dense - South orientation -tortuous alleys - Overall direction - Towards Mecca 	<ul style="list-style-type: none"> -blocking the harsh climate - Religious beliefs -maximum shadow coverage
Sidewalks		<ul style="list-style-type: none"> -tortuous - Narrow -roofed - South direction - Tall walls on side 	<ul style="list-style-type: none"> -shape dense tissue - prevent hot air descent -block sunlight - makes shadow
Facades		<ul style="list-style-type: none"> -few openings to outside - Light and high -blocked by neighboring houses 	<ul style="list-style-type: none"> -reduce external Surfaces against harsh climate - reflecting sunlight
Walls & materials		<ul style="list-style-type: none"> -excavated from ground underneath the house - Thick walls 	<ul style="list-style-type: none"> -a bundat - Cheap - supporting the roof - reducing fluctuation
Entrance		<ul style="list-style-type: none"> -single door - Sequential entrance 	<ul style="list-style-type: none"> -thermal filter - providing privacy - prevent inside cool air from exiting
Courtyard		<ul style="list-style-type: none"> -closed and surrounded by tall masses - shallow pool - shaping isolated microclimate 	<ul style="list-style-type: none"> -harsh climate - keeping the cool air inside - simulate air-flow - increase shadow - Humidifier
Underground spaces		<ul style="list-style-type: none"> -dugged underneath the house - Occasional pool 	<ul style="list-style-type: none"> -less temperature Fluctuation - cool in summer -warm in winter - access point for qanat
porches		<ul style="list-style-type: none"> -usually facing north - Supplied with wind-catcher 	<ul style="list-style-type: none"> -stimulate air-flow inside the house - provide a comfortable semi-open space
Différent antichambre/ alcôve		<ul style="list-style-type: none"> -different vaults and domes -thick - Symmetric - made of adobe 	<ul style="list-style-type: none"> - lead winds with different directions towards - delay heat-flow
Wind catcher		<ul style="list-style-type: none"> -tall&multisided -different in size&shape -most houses use a wind-catcher 	<ul style="list-style-type: none"> -cool winds blow high -dense tissue -sign of socio-economic situation

Figure 24. Element of the sustainability in the saharian geography.

mined or modified them (site, climate, materials), these factors are all related to two entities: the man and his environment.

Man, being the generator of this conception, referred in design to its social environment (the whole community in which it evolves itself, or on a smaller scale, his family, as well as the types of relationships he has with her). For Rapoport, the construction of a house is a cultural phenomenon, and its form and layout are strongly influenced by the cultural milieu to which it belongs. Through his analysis Rapoport refutes any classification of the forms of the house that would induce the physical aspects as a single causal factor. The physical aspects and the socio-cultural aspects must be taken into consideration, “but it is these that must first be emphasized. [...] The specific characteristics of a culture - the accepted way of doing things, the socially unacceptable acts and the implicit ideals - must be taken into consideration since they affect the shape of the house and the agglomeration» (Mateus and Oliveira, 2009).

6. Conclusion

The motivation of this study is related to the fact that the type of popular Saharan houses is being lost. Ignorance of inheritance “popular” causes the drift of the authenticity of local architecture that adapts to the environment and the rigor of warm climates. Concept which allows reproducing models “simple” typical in an era when climate change is needed. (See figure 24).

Acknowledgments

The authors thank the University and laboratory ARCHIPEL.

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