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ACCLIMATIZATION MEASURES FOR TEMPORARY REFUGEE SHELTERS IN HOT ARID CLIMATES; LOW-TECH MOBILE SOLUTIONS USING BEDOUIN TENTS

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Fig 1: Collage images for Tolyane refugee camp in Lebanon one of the case studies.

Research summary

Global climate change has enormous impacts on urban areas in the developing world. The known and growing effects of climate change like increased temperatures and increased incidence of severe storms are evident. This winter 2015, an extreme cold waves and snow storms hit the Middle East region. Death rates in Syrian refugee camps were significant due to inefficient temporary shelters. Children and seniors were typically the most vulnerable. In addition the urban structure do not consider social needs and culture behavior. This paper is showing an investigative study for current social and environmental problems within Syrian refugee camps in Jordan, Egypt and Lebanon. The study is proposing a suggestion for development through analyzing Bedouin communities in the Middle East for possible use of Bedouin tents structure and clustering as a resilient solution for housing and shelter. That is through understanding the environmental behavior of the Bedouin tent structure together with socio-cultural implications among the Bedouin community. The paper applied an investigative and analytical approach using qualitative site survey methods. It concluded by defining thermal comfort adaptation measures and social clustering adopted by local Bedouin inhabitants inside their tents and draws applicable and hands on proposal for using such adaptation measures in current low-tech emergency shelters, especially for those on low-income refugees.

Keywords: Temporary refugee shelters, low-tech, energy efficiency, socio-cultural, Bedouin tent

1. Introduction and study background

Natural disasters and wars are two main reasons that force population to leave their homes, which consequently pushes for an urgent need to provide temporary shelters or settlements as a disaster management plan. Since many years, governments and aid agencies work on offering emergency relief camps. Shelters can range from short term to long term stay ones. Tent is the most common shelter structure used. Studies show that the majority of current tent shelters do not satisfy comfort conditions of occupants (Obun et al., 2015) and hardly satisfy privacy, hygiene and other social needs (UNHCR, 2006). Also expensive in fabrication and they deteriorate quickly (Manfield et al., 2004).

Several countries in the Middle East had experienced a lot from the above-mentioned challenges to accommodate Syrian refugees since the uprising began in March 2011. Many quick shelter camps have been erected to safeguard thousands of refugees in Egypt, Jordan and Lebanon. Observing shelters in the three different contexts showed similarities in common problems especially with social inconvenience and thermo-hygrometric comfort conditions. Such issues were proved by several researchers (Obyn et al., 2015; Rudge & Gilchrist, 2007) to be evident for many health hazards and increase death rates both in warm and cold conditions. Another major issue is energy support. As the Middle East is suffering recently from energy poverty, fuel intake in refugee camps appeared not only being a problem in terms of availability and cost but a problem in logistics as well.

The lack of interest in researching both social and environmental aspects in shelters as interconnected issues is unfortunate. The rapid increase of death rate and conflicts between occupants inside camps is an alarm that signals an urgency to find a solution. In our study, we tried to lay hands on problems from urban and architecture perspective and to offer an understanding for the correlation between socio-cultural aspects and energy efficiency in those emergency shelters.

This study shows a proposal on how to achieve the compromise of indoor and outdoor comfort together with decent private social life for refugees built on studying traditional Bedouin tents in the Middle East region. The results revealed that we can drive practical lessons for contemporary emergency shelters from understanding the thermal performance as well as the social behaviour of Bedouin tents. This paper in hand tried to fill in a knowledge gap by investigating the two issues and tried to propose a recommendation towards an applicable solution.

2. Discourse study

Several robust research had tackled the problems of emergency shelters from structural design and construction perspective, focusing on adaptability and compatibility (Manfield et al., 2004). Some others focused on the socio-cultural aspects (Kumssa & Jones, 2014). Several research work found focused on thermal performance or energy efficiency of shelters (Crawford et al., 2005; Saleh, 2011). Other shows contribution in achieving thermal comfort while developing useful applications for prototypes considering cost, weight, volume and time for assembly (Manfield, 2000). Over the recent years, some international research laboratories focused on studying shelters indoor thermal conditions (Obyn et al., 2015), besides the effort of various humanitarian organizations to come up

with effective solution using low tech and passive strategies together with researchers investigating the use of high tech materials (Cornaro et al., 2015).

To our knowledge very limited studies just touched on the surface the connection between social aspects and technical aspects of refugee shelters. We could not find robust published studies tackling both challenges; how to achieve a humanitarian shelter that respects the socio-cultural norms of the refugees together while offering a comfortable and energy efficient shelter.

3. Methodology

The methodology is based on two phases; first, investigative and exploratory observations for existing emergency refuges shelters for Syrian citizens constructed after 2011 in three countries; Egypt, Jordan and Lebanon. Followed by a second analytical explanatory study for Bedouin clustering communities in the same countries. The two phases were supported by in depth literature study for previous research on environmental and social issues with refugee camps. This research used set of qualitative survey tools like interviews, questionnaires, field notes, photographing. The mix of tools were to document any field observations and to sketch some architecture and urban details needed for the study.

First, an investigative and observatory study was carried out using qualitative structured interviews with random samples for occupants in refugee camps. Total of twenty local inhabitants were interviewed, twelve women and eight men. Together with fifteen walking semi structured interviews with ten men and five women. The age range was between eight and seventy years old. The questions were mainly investigating current problems that refugees are suffering from both in terms of indoor thermal comfort and social needs. In addition, they were questioned about their adaptive and inventive solutions they use to cope with their current situation.

Then, site visits were made to three Bedouin communities to study the Bedouin tents as a unit structure, to understand their thermal performance and their clustering formation together with social aspects that affects their placement. The internal zoning inside the tent as well as the positing of group on tents were both of concern. Nine interviews were made with Bedouin inhabitants, three in each case, to collect more information about climatic adaptation methods and tent construction techniques together with materials used. Other questions were also of concern like, how local Bedouin manoeuvre inside and outside the tent, according to their cultural and social concerns, what functions are accommodated inside the tent and what are the outdoor activities and why. Specific questions were for Bedouin women inquiring about their roles in construing the tent, as they were responsible for spinning goat hair as a tent material.

4. The Bedouin tent as an alternative

The study of Bedouin communities in the Middle East has been discussed over the years and drawn the attention of many scholars and researcher (Weir, 1976, Katakura, 1977; Ingham, 1986). It is discussed in literature that a Bedouin tent is more than a shelter and a place to sleep or to meet guests (Dehau & Bonte 2007). The Bedouins call it beit sha’r as the tent cloth is woven from goat hair or a mixture of sheep wool and camel hair.

We can define the Bedouin tent as a tensile lightweight and transportable method of construction. Giller discussed in her study that what distinguishes it from the rest of the methods of construction is the use of a flexible membrane as a skin for a habitable space. She highlighted how the tent envelope is an adaptable mobile shelter and that is one of its potential. The tensile tension is what gives this kind of structures the minimal thickness in order to resist loads, allow for large spans and gives it the remarkable ease of transportation (Giller, 2012).

Lewis shows how responsiveness is considered an inherent quality of Bedouin tents, as they can be responsive to their environment in more than one aspect (Lewis, 1987). Giller also showed how tents can adapt to a variety of environments from the most arid to the coldest ones. They can fit different functions and cultures (Giller, 2012). In other words, tents not only can adapt to the forces that shape them but also to the experience they provide as a shelter.

What also makes tents even more appropriate for the situation of the Syrian refugees, in terms of acceptance, is from our observations, most of the refugees are from rural background. Referring to Faegre, this come in consistency with origins of the black tent as the Arab type of the black tents is widely used by the Bedouin tribes in Iraq and Syria (Faegre, 1979).

4.1 Bedouin tent design & construction materials

Tents changeable form is a direct response to the inhabitants' lifestyle, needs, wealth and social status. The tent parts are divided into functional zones like the kitchen location, the sleeping ,the sitting area, and the guests' zone. The tent location is directly related to its landscape and its setting.

Black tent dwellers were originally weavers using goat, camel and sheep hair. They weaved not only the tents cloth but furnished these tents with spindle bags, carpetbags and carpets all in rich colours and intricate geometrical design (Faegre, 1979). This brings up the potential of re-producing the tent cloths for the refugees' camps if we were able to repeat the production mode among the refugees.

4.2 Bedouin Tent environmental qualities

From our site investigation, we deduced that in the Bedouin culture, the tent is constructed in relation to the natural topography and the sun. Bedouin families pack up their tents and move towards the sun in autumn and winter then away from it in summer. The orientation of the tent changes during summer and winter as well.

In wintertime the tent is orientated to face south to make maximum use of the sun, to penetrate the interior of the tent. The closed part of the tent is placed against strong cold harsh winds and rain. The wool as a fine natural material act as a heat absorber and trap heat inside. As for the rain protection, the yarn swells when wet, closing the holes. In addition the oiliness of the natural hair blocks the rain and holding off water. During winter cold nights, locals put on the fire in the middle of the tent and that makes the wool pores get even smaller when exposed to smoke. That helps again in trapping the heat inside the tent.

In the summer, the tent living zone is placed facing pleasant prevailing cool winds. The sleeping zones faces the east to allow the

morning sun to be stored in the tent envelop for cold summer nights. While the solid parts is positioned against the sandy seasonal storms. In summer the tent offer an opportunity for natural ventilation with its open sides for air exchange and top openings for air scape. Inside the tent, stack effect is powered by the buoyancy of air, which depends on the pressure difference between inside cool air and outside warm air. The greatest the temperature difference, the greater the buoyancy effect. The tent valance also can be raised or lowered upon need to enhance ventilation or provide shade. Its cloth opens up like horizontal awnings to form a sunshade. The tent wool material provides good shading despite its dark brown or black colour that is assumed to absorb heat from the sun. Its loose weave lets the heat inside disperse, and encourage heat release through its pores. That makes the indoor temperature lower than the outside.

The Bedouin tent wool material has many other adaptive thermal properties, shown in table (1). Based on Mauersberger & Matthew, the natural hand woven wool is characterised by its springiness, resilience with low thermal conductivity, elasticity and moisture retaining and thermal insulation properties (Mauersberger & Matthew (red.), 1947). The wool is a highly hygroscopic fibres, that means is has a tendency to maintain temperature; hence, the unique insulating properties of wool. Harmsworth & Day discussed that natural wool (goat, camel and sheep wool) absorb and retain considerable amounts of moisture from the atmosphere and that is distributed in capillary spaces between fibres. They also explained that through moisture absorption, the fibres prevent rapid temperature changes (Harmsworth & Day 1990).

Table 1. Wool thermo-physical properties.

Properties	value
Thermal conductivity λ[W/mK]	0.033
Water vapour permeability [g/(24 h m^2)] – ASTM E96	2000
U value	0.07
Density KG/M3	25
Specific Heat Capacity [c[J/kgK]	710
Fire Resistance Classification [DIN4102]	B2

4.3 Bedouin tent and socio-cultural qualities

The tent is not only a shelter it is a social arena where socio-cultural values and norms are constantly produced and reproduced. The tent components are located in away assuring privacy and separating males from females when needed. The urban clustering of tents creates hierarchy of spaces from private, semi private, to semi-public and public. Comparing the urban layout of traditional Bedouin communities to current state in refugee camps, we observed the following:

The organization of refugee camps lack this hierarchy of open spaces that exist in between the tents and this can be classified in three main categories:

-Public common shared spaces where women meet, do their laundry, cook or wash and other spaces where men meet to socialize and chat as shown in figure (2). Such spaces rarely exist or are very small spaces to accommodate such activities.

Figure (2) Spaces where men gather to socialize and to have coffee or tea.

-Semi public or private spaces that is threshold between the private realm of the tent and the public realm of the areas around it. This in-between space is where refugee has the capacity to control the amount of interaction. This threshold is just an edge which is the membrane of the tent itself. In some cases especially in Tolyane camp in Lebanon, some of the tents have expanded this space using elements such as curbs or planters or even light structures from wood and cardboard sheets.

-Satellite play spaces in-between the tents, which were observed to be efficient in addition to central ones. They may contain some simple elements with a non-defined use made from recycled materials and tires. These spaces can be mainly used for children to play while their mothers could keep an eye on them while sitting in the tent. Such simple elements where neighbours can interact, can increase the sense of community within the camps. The collage images in figure (1) shows the current situation and explains such hierarchy of spaces.

5. Towards an adaptive refugee camp proposal

Through defining Bedouin local inhabitants' social and thermal comfort adaptation measures inside and outside their tents and adaptation to the extreme weather conditions in summer and winter, we tried to draw applicable and low-tech hands on solutions for current low tech temporary shelters. We have put into consideration common household activities and shared facilities.

From our site investigations, we realised that intervention in refugee camps walks on the borderline between 'permanentization' of the camps and the improvement of living conditions with maintaining the temporality of these settlements. Faegre stated that the lifespan of Bedouin tent cloth is usually from five to six years (Faegre, 1979). That is an adequate average life time for a temporary shelter.

On the social and humanitarian level, the internal organization of the tent should always reflect the social needs of occupants. Tent does not have clear boundaries between the inside and the outside. The interior of the tent can be extended using the internal mats creating a porch (*fina'*). The space outside the tent should occupy practical functions. Some of these functions are more related to women where they gather for cleaning, washing or cooking and other intermediate zones for other shared facilities like toilets and showers while still assuring privacy.

Figure (3), shows our proposed steps to set up a refugee camp using the Arab black tent structure. The plot for setting up a camp is proposed to be divided into a basic grid of approximately 6 x 3 meters to be assigned to the refugee families according to the number of persons in each family. A preliminary network of passages and corridors is set between the basic parcels. Each family gets a fabric and set of poles to divide up the internal space of the tent according to their needs. The straight corridors and passages between the tents creates in-between spaces that differ in size which can provide more potential for the social activities such as receiving guest while still preserving privacy.

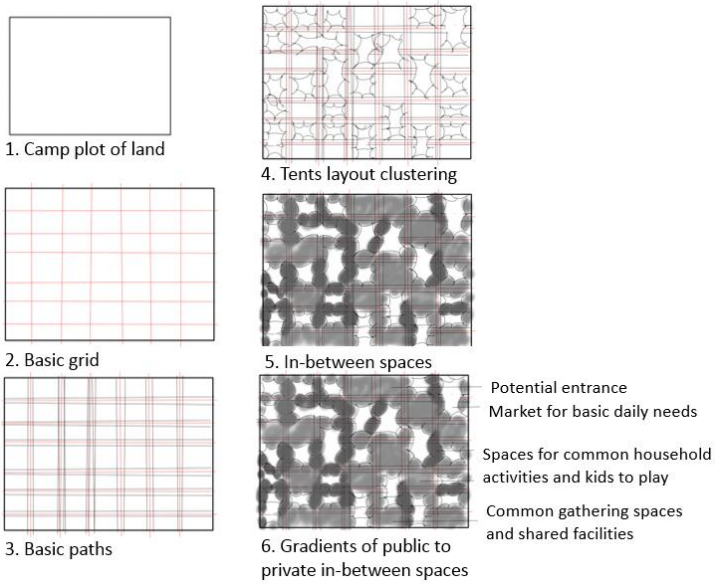

Figure (3) Proposed clustering and grid design for the camp site set up.

While for the environmental aspects the new grid proposal offers intermediate spaces that regulate the outdoor temperature between the tents. The shaded zones can serve as fields, storing cool air. While the unshaded zones will serve as containers for hot air. The difference in air pressure in both zones, will enhance air circulation in between the tents offering cold air breeze. In winter all the open spaces will be unshaded and directly exposed to the sun, in addition the irregular shapes of the streets network will act as windbreakers. It will help reducing wind speed and velocity in winter time.

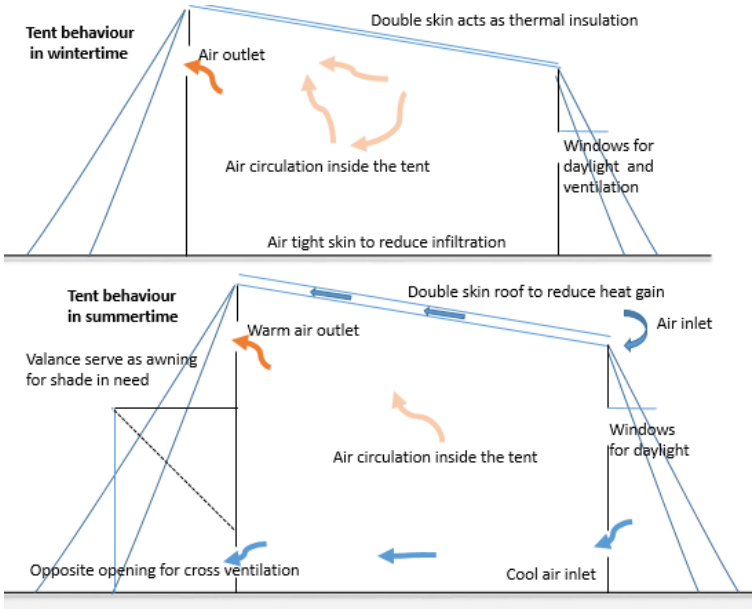

Figure (4) Proposed solution for thermal adaptation in summer and winter.

For the tent material, we propose using natural wool because of its thermal properties and durability discussed earlier. The roof part will be double skin making use of tensile flexible properties of the wool which will allow for stretching this double skin structure. In summer an air gap is created between the two layers to allow for air movement and reduce heat gain while in winter the two layers create a thick thermal insulation. The internal height of the tent in summertime is higher to allow for the hot air with low density to escape from the top opening of the tent. While in winter the height is reduced to keep the internal heat gain with closed sides to assure air tightness and reduce infiltration. In addition the top surface can be stretched in an inclined form in winter for rain and snow fall.

6. Conclusion

This study address the growing concerns about the impacts of the rapid change in climatic conditions on refugee camps and showed in a practical way how we can provide a comfortable and socially adaptive shelter. The flexible grid layout proposal had two main benefits; first will allow adjusting the tent orientation according to the climate and season variations. That will enhance the thermal indoor and outdoor comfort level for the majority of the year. Second this resilient adjustable structure according to occupant refugees' needs, respected their social and cultural preferences. Our study focused on using passive solutions but active means will be sometimes necessary to use but at least will be in limited occasions with least energy.

This study concluded that the Bedouin tent still remain a resilient tensile structure that can be quickly erected or dismantled with several environmental potentials. We hope this study can be developed further as tested prototypes for adaptive solution to climate challenges and offering decent shelters for urban poor refugees.

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