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A quantitative and qualitative thermal comfort assessment in urban public squares of the inhabitants of desert regions

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Abstract. This article examines the indicators of residents' needs for thermal comfort in public spaces. Our hypothesis focuses on the extent to which high temperatures are associated with the use of public spaces by different age groups of the population. The public squares that distinguish the urban areas of the case study were selected based on their importance and location in the city centre. The research methodology is based on numerous research techniques: Onsite measurements, observation schemes and questionnaires. The most important results obtained for a better design of the public Square must be adapted to the needs of the user taking into account essential elements such as: the quality of the equipment of the place, the type and density of the vegetation, the inclusion of water bodies and the perception of the inhabitants...etc, in addition to giving importance and highlighting the social and cultural aspects and the identity of the region.

Keywords. Public square users, Thermal environment, Onsite measurement, Questionnaire.

1. Introduction

Recognizing the identity of the city takes place through its streets and public places, where the public square plays a permanent link between the various segments of civil society, where they weave social relations between them. Appropriate planning and design processes for public squares raise questions about the right to freedom of expression and assembly and the empowerment of civil society to enjoy, share and exchange with one another. Well-designed and maintained public squares can increase occupancy rates and provide spaces for social, cultural and economic activities that help improve mutual relations and security. Badar et al. 2020 stressed the relation between place and identity. The aims of Kolawole et al. 2020 research work are to: access on the recreational facilities available at case study Park, to examine the level of maintenance of the recreational facilities for visitors delight.

Despite the availability of many public squares, their exploitation is still in small proportions, as the high temperatures in desert areas negatively affect the use of the outdoor urban spaces of cities (RUROS, 2004). In regions with a hot climate, age groups of the population have different thermal sensation, recognizing the appropriate conditions in an open urban space requires careful design that takes into account several physical and psychological aspects (Guedouh, 2011). When these spaces are inappropriate, poorly conceived, or privatized,

they become sites of increased isolation. Planning public squares on the basis of the individual, identity, environment, gender and economic status, may produce polarized spaces, where social dynamics are possible.

This research is based on the investigative approach using the techniques of the questionnaire and the observation scheme. The questionnaire is based on a set of open and semi-open questions (the questionnaire form) based on a photographic album organized in such a way as to awaken the psychomotor awareness of the respondents, while the field observation is based on peaceful benchmarks to be measured daily the seasonal occupancy rates of the public squares studied.

2. Case study

2.1. Biskra city center

The change related to the regional reorganization in 1974 brought about the emergence of Biskra as an important regional urban center. Biskra is located in an area characterized by a hot arid climate (cold winters and hot dry summers). The prevailing wind is the northwest wind (cold wind) that blows from November to May. The hot southeast wind blows from July to September.









Figure 1. Biskra location in Algeria (Source: <http://www.mondecarte.com/carte/biskra-carte>).

2.2. Public squares samples

The public squares selected for research are public squares of importance and well-known to the residents of the city, where many criteria were taken for their selection, including: the strategic location relative to the neighboring neighborhoods and streets, regularly frequented by the residents of the region, functional and their services diversity, natural and artificial elements possession: vegetations, water bodies and urban seats. These squares have been selected to cover the maximum of physical properties and factors that have an impact on the thermal environment and the well-being of the square's users.




Table 1. Public spaces selected for the study.

Square 1	Square 2	Square 3
		
<ul style="list-style-type: none"> - Double-structured configuration (regular and curved) - presence of green space - Provides a variety of services: cafes, restaurants, kiosks...etc. 	<ul style="list-style-type: none"> - Embedded on site (stone mountain) - Located in the center of the city - Use of half-covered corridors - Small use of the green spaces (vegetation and grass) 	<ul style="list-style-type: none"> - A strategic location in the city center - Using green space and water (waterfalls) - Provides a variety of services: cafes, restaurants, kiosks...etc.
		

3. Measurement Campaigns

Measurement campaigns were conducted in the summer season to measure air temperatures of the square samples. These onsite measurements aim to determine the impact of square's components on the thermal environment. Bi-hourly measurements were taken during hot summer days; from 06:00am to 00:00am. Thereafter, the averages of air temperature rates have been calculated and compared of the three samples studied to extract the most appropriate components of a square in a hot arid region.

Table 2. Physical components of the public squares studied.

Square 1	Square 2	Square 3
		
<ul style="list-style-type: none"> - Square boundary - - - - Concrete pavement - Vegetation density: 15% - Shadow devices: pergola - water body: absent 	<ul style="list-style-type: none"> - Square boundary - - - - Concrete pavement - Vegetation density: 10% - Shadow devices: pergola - water body: present 	<ul style="list-style-type: none"> - Square boundary - - - - Stone pavement - Vegetation density: 20% - Shadow devices: pergola - water body: present

The results obtained for the studied square samples show different thermal environments, according to the morphological characteristics of the square (type of pavement, horizontal and vertical surface coating, water bodies, surface's colour and vegetation). The figure bellow shows the thermal environment resulting from the different urban squares studied.

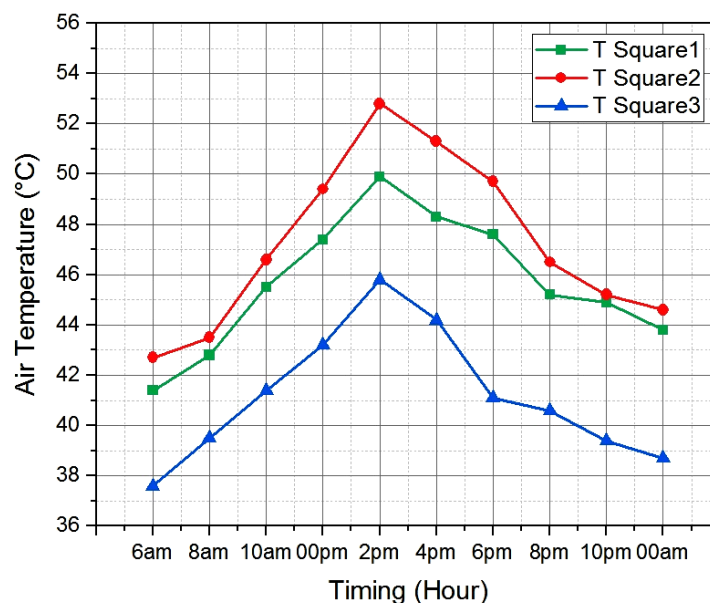


Figure 2. Air temperature variation in each square sample studied (Source: Author).

4. The questionnaire

In this part, we will present the idea of a qualitative evaluation based on a questionnaire and the photography album of the squares (Cherqui, 2005). The aim of the questionnaire is to establish a relationship between the respondents and the thermal environment and turnout rates

in the scene, through field interviews, clarifying the position and opinions of the interviewed samples and obtaining the maximum possible data based on the photography album attached to the pictures to express their perceptions of the scene appropriate to their requirements (Hégron, Torgue, 2007). We sought a statistical representation of the samples according to gender and age, the images were presented to the interrogated samples in an objective way that corresponds to seasonal daily temperature changes (Chelkoff, 2006), which helps to activate the mental images related to their daily behavior, especially in the squares.

4.1. Question's survey

In a first stage, and due to the difficulty related to estimating the respondents' sense of the thermal atmosphere in the squares, the questionnaire form was supported with an album of photography of the studied squares in a directed manner relative to the criteria related to the characteristics of the square, which enables them to provide appropriate perceptions (Tahrani, 2006), the second stage of the questionnaire aims to delve deeper in the respondents' ideas with open questions to express the supposed reality that reflects their social, cultural and psychological aspirations, which include the characteristics of the square in terms of its dynamic and sensory atmosphere (Chaabouni, 2006). Indicators and semantic terms of quality allow showing the links and logical interrelated relationships between thermal perception and morphological elements of the scene.

4.2. Scales of evaluation

Table 2 below shows the different quantitative and qualitative scales of the evaluation to assess the different indicators of the research. The objective is to correlate between physical and psychological parameters of the studied squares to the user's occupancy rate.

Table 3. Physical components of the public squares studied.

	Sensorial scale (from -2 to +2)				
Scale 1	Very hot -2	Hot -1	Stuffy 0	Less hot +1	Cool +2
Scale 2	Tedious -2	Disagreeable -1	Agreeable 0	Admirable +1	Memoirable +2
Scale 3	Few -2	Occasional -1	Normal 0	Considerable +1	Lot +2

The respondents showed attention to the features of the square (the axes of transit, the training for the expediency of users, activities with the available services, shading device, playgrounds for children and gathering places for women...etc). The respondents focused on quality and a sense of safety in the absence of a physical embodiment of the fulfilling elements of his desires. It seems that the architectural layout has a dynamic character that includes several criteria that take into account the thermal atmosphere to improve the thermal feeling suitable for users more than water and vegetation. The figure 3 bellow demonstrates that the air temperature values perfectly match the thermal sensation of users.

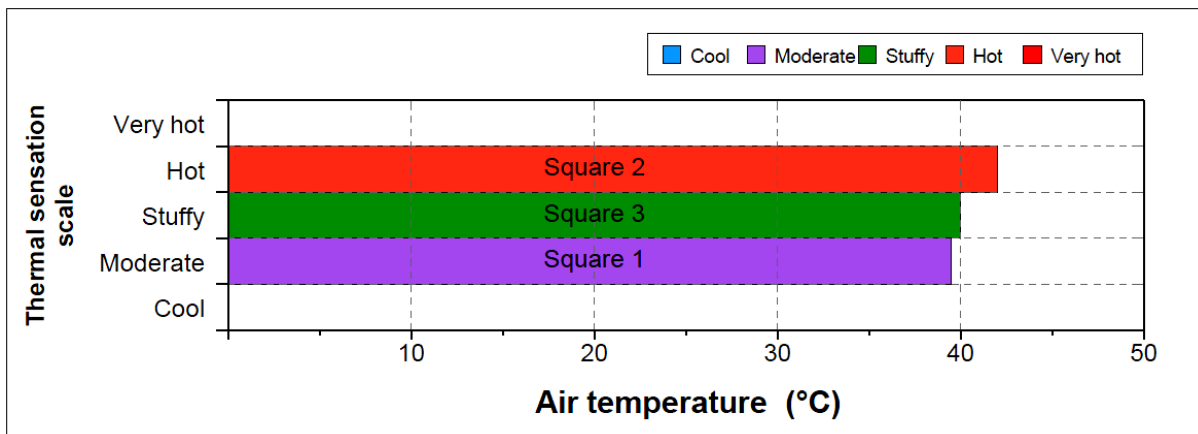


Figure 3. Perceptual qualification related to air temperature (Source: Author).

The relationship between the perceptual sensitivity of users and the temperatures in the square is inversely related, as the higher the temperature, the lower the rate of turnout for it. Turnout rates remain normal in the arena despite the extreme climate condition (too hot in summer season or too cold in winter season). The figure 4 below shows how strong is the occupancy rates are related to the thermal sensation of users; the coolest is the thermal sensation is the most considerably is the frequency rates.

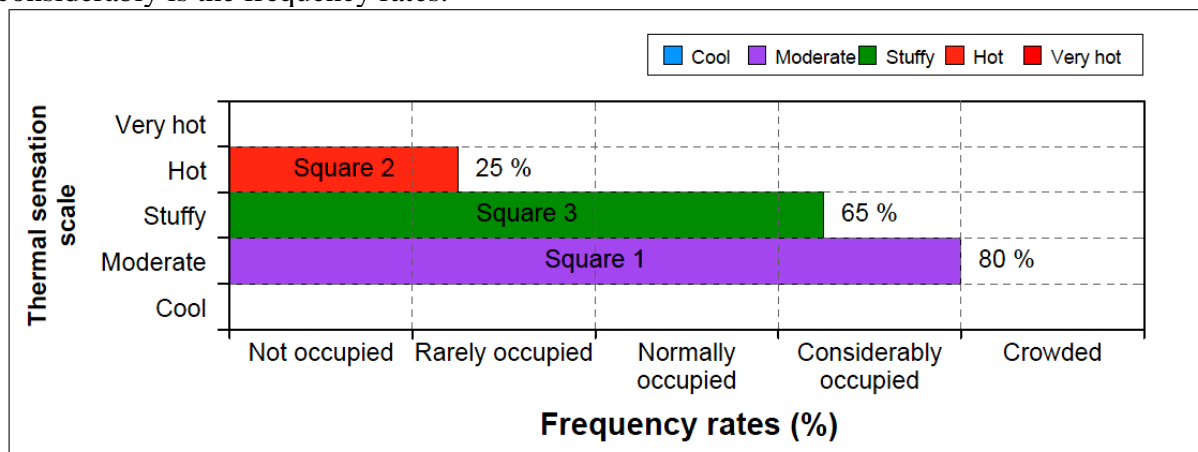


Figure 4. Frequency rates according to thermal sensation (Source: Author).

5. General recommendations

Among the recommendations to raise the occupancy rate and provide the conditions for the of user’s requirements of a public squares and to improve the thermal environment; the thermal environment is linked to several indicators of a climatic and urban nature, such as: strategic location in the city center, convenient social environment, surrounding population density, mitigation of the atmosphere (intensification of green space and water bodies) while providing areas for specific services to the requirements of different age groups (children, men and elderly), distinguish gender spaces for males and females for society belief reasons. And for last the identity and cultural touch should be present in the square design to increase the society attachment.

Conclusion

According to the characteristics of the regions, the occupancy rates of public squares are due to a variety of reasons, such as: functional diversity and services (cafes, children's play areas), pavement type, microclimate quality using shade of plants and water evaporation, equipment made with wooden or steel and avoiding concrete... etc., all of these elements have a positive effect on the thermal environment, as well as on the frequency rate of public squares in urban desert areas, where intense sunlight prevails most of the year.

Perceptions of the urban public square user have greatly influenced our fieldwork; they contributed to verifying the validity of the proposed hypotheses about the role of thermal environment quality and urban space physical characteristics in increasing occupancy rates. Through determining their desires and feelings, a reclassification of the thermal environment perception has been established prevailing in the square and the well-being of the inhabitants. The field survey showed the link between urban built space and users' aspirations, which means that users' perception goes beyond any quantitative values of psychological comfort, morphological parameters and socio-cultural aspects are also part of sensorial well-being.

This study propose research's future axes, such as studying other environments, such as: luminous and acoustic environments, that affect the users comfort and reach the maximum occupancy rates of public places in hot regions. At present, numerical simulation software recently, such as: space syntax, can contribute to the study of proposals for different square design models under different climatic conditions.

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